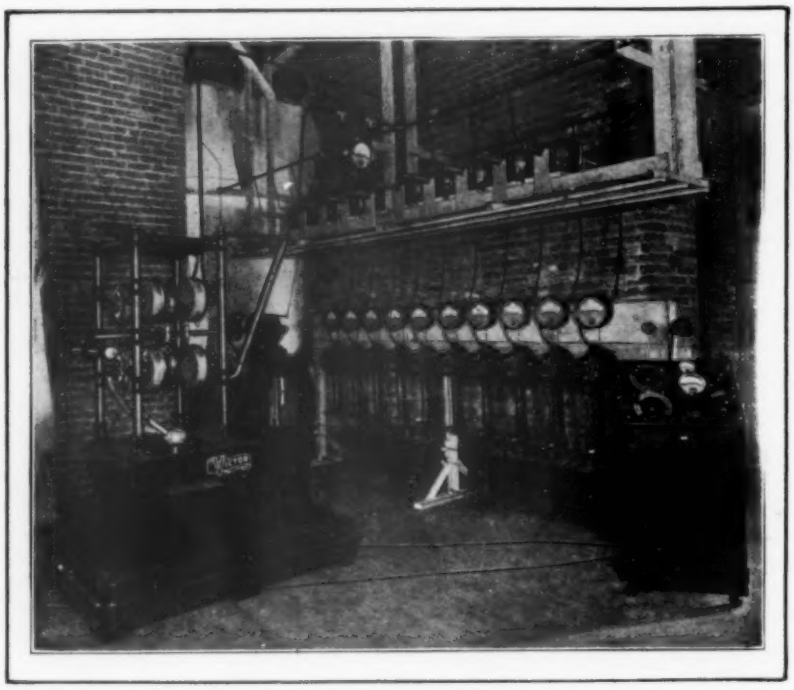
JUL 17 1923 Medical Lib

THE JOURNAL OF RADIOLOGY

Vol. IV JULY, 1923 No. 7

PUBLISHED MONTHLY BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA
AT OMAHA, NEBRASKA



PROOF BY PERFORMANCE

The "Snook-Special" Deep Therapy Diagnostic Machine Proves Up Under Supreme Test

THE design of the "Snook-Special" Deep Therapy Diagnostic Machine was to provide for not only the present 200,000-volt Coolidge tube of 8 milliamperes capacity, but also in view of future Coolidge tube developments calling for higher milliamperes at this voltage.

It was desired that when offering the "Snook-Special" to the Roentgenologist a definite statement regarding its capacity could be made, substantiated by records of actual performance.

To conduct a test under conditions which would be practically equivalent to those which would prevail were a 30 M. A. Coolidge Tube available, Victor engineers connected in parallel ten deep therapy Coolidge tubes of the present type, each with a separate Victor-Kearsley Stabilizer and filament transformer, thus providing means for control of current in each tube, independent of the others. With the "Snook-Special" delivering 30 milliamperes of current, these tubes are energized simultaneously, at an average of 3 M. A. in each tube.

This set-up has been running almost daily for some months past in our factory experimental department, and has furnished conclusive proof of its operating ability to many visiting Roentgenologists.

This demonstration is for the purpose of proving machine capacity and performance under conditions more difficult and exacting than any X-ray machine has ever been called on to meet. This is not intended as a demonstration of the feasibility of running tubes in multiple.

A bulletin containing complete description of the "Snook-Special" will be sent on request

VICTOR X-RAY CORPORATION, Jackson Blvd. at Robey St., Chicago

Sales Offices and Service Stations in All Principal Cities

VICTOR

The JOURNAL OF RADIOLOGY
Omaha, Nebraska
VOL. IV JULY, 1923 No. 7

Radiography in the Examination of the Urinary Tract*

CHARLES G. SUTHERLAND, M. B. (Tor.)
Mayo Clinic
Rochester, Minnesota

MUCH interest has been expressed regarding the findings and technique in the roentgenologic examination of the urinary tract. In view of this, I selected for study the consecutive histories of 1,000 patients from 6,908 in whom the urinary tract had been examined roentgenologically in the Mayo Clinic in 1921. These 1,000 patients represent approximately ten per cent of the patients who registered in the Clinic during this time. Registration numbers are issued to the patients in numerical sequence; thus it is possible to carry out an accurate statistical study of the findings in any series of cases. Five hundred and eight of the patients were males and four hundred and ninety-two females. Their ages varied from:

Years	Patients	Years	Patients
1 to 10	7	51 to 60	189
11 to 20	28	61 to 70	118
21 to 30	140	71 to 80	22
31 to 40	258	81 to 90	2
41 to 50	236		

The youngest patient was 3 years of age; the oldest 83.

Of the 1,000 cases studied, the roentgenologic findings were negative in 624 (62.4 per cent). The positive findings are presented in tabular form (Tables 1 and 2).

Since my purpose in making this study was to trace the ultimate findings in a series of one thousand routine investigations of the urinary tract I have combined the cystoscopic and surgical findings for the obvious reason that in many instances the cystoscopic and the surgical findings were identical, patients often being referred for surgical treatment as a result of the cystoscopic findings.

One or more of these conditions may exist in the same patient; for example, pyonephrosis with multiple stones, or associated deformities and lesions of the ureters such as hydro-ureter and strictures with dilatation; these, however, were not charted as definite entities.

Cystoscopic examination was made in 327 (32.7 per cent) of the one thousand cases, and the findings proved to be negative in 62 (18.96 per cent).

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 7, 1922.

TABLE I.

Stones diagnosed from roentgenograms and found by cystoscopic or surgical examination in the urinary tract.

KIDNEY	URETER	BLADDER
Males 29	Males 9	Males 6
Years	Years	Years
Youngest 33	Youngest 31	Youngest 31
Oldest 60	Oldest 61	Oldest 77
Average 45	Average 45	Average 52
Females 8	Females 5	
Youngest 18	Youngest 22	
Oldest 67	Oldest 53	
Average 43	Average 36	
Stones not diagnosed from roentgenograms, but found by cystoscopic or surgical examination—**		
Males 3	Males 6	Males 4
Youngest 30	Youngest 23	Youngest 56
Oldest 50	Oldest 43	Oldest 66
Average 39	Average 34	Average 63
Females 1	Females 4	
Average 41	Youngest 40	
	Oldest 53	
	Average 47	
Stones diagnosed from roentgenograms and ruled out by cystoscopic examination		
Males 2	Males 6	Males 3
Youngest 41	Youngest 29	Youngest 36
Oldest 55	Oldest 65	Oldest 63
Average 48	Average 50	Average 52
Females 2	Females 8	
Youngest 36	Youngest 35	
Oldest 62	Oldest 71	
Average 49	Average 48	
Stones diagnosed from roentgenograms and not found by cystoscopic examination		
Males 12	Males 6	One prostrate shadow reported was calcified prostate.
Youngest 19	Youngest 23	
Oldest 65	Oldest 43	
Average 43	Average 34	
Females 15	Females 4	
Youngest 19	Youngest 40	
Oldest 61	Oldest 53	
Average 45	Average 46	
Total 41	Total 24	Total 10
Right side 15	Right side 13	
Left side 23	Left side 10	
Bilateral 3	Bilateral 1	

*—6 were reported as phleboliths

ULTIMATE DIAGNOSIS IN CASES NEGATIVE FOR LESIONS OF THE URINARY TRACT

In 114 of the 624 patients in whom the findings were negative roentgenologically, the ultimate diagnosis was cholecystitis. Of these, a clinical diagnosis was made of cholecystitis in 50, of cholecystitis with stones in 11, cholecystitis was found at operation in 15, and cholecystitis with stones, at operation in 38.

Forty-three of the 624 patients had appendicitis; in 22 the condition was diagnosed clinically; in 21 it was found at operation.

Three hundred and seventy-six patients (37.6 per cent) had phleboliths; 197 of these were males (average age, 48 years) and 179 females (average age, 44). Phleboliths are small, calcified thrombi on the distal sides of the valves in the vesico-prostatic and the vesico-uterine plexuses around the base and neck of the bladder and the prostate gland in the male, and around the base and neck of the bladder and the vagina in the female. In advanced life the veins of these plexuses become enormously distended and varicosed and often contain small concretions. They are usually multiple and are seen commonly in the region of the ischial tuberosities and lower pelvis. They are sharply outlined, circular or oval in shape, and although they do not ordinarily offer any difficulty, their location may make it hard to distinguish them from small ureteral calculi. In 22 cases of ureteral stone found at cystoscopic examination or at operation six had been diagnosed from the roentgenograms as phleboliths.

Hypertrophic arthritis was an incidental finding in 82 patients, 61 males (average age 56) and 21 females (average age 51). This lesion increases in frequency of incidence as age advances and may cause pain simulating that of stone or other lesion in the urinary tract.

Bifurcation and sacralization of the transverse processes of the fifth lumbar vertebra was another incidental finding in 20 cases, which like hypertrophic arthritis, might cause pain and, associated with urinary findings, would suggest investigation of the urinary tract. Spina bifida occulta was reported in 28 instances. While these congenital defects of development in the fifth lumbar or the upper sacral segments commonly have no clinical significance, they are infrequently associated with obscure disturbances of sphincter control, motor paralyses and sensory disturbances, and the knowledge of their existence is of value to the neurologist, particularly if patients have retention of urine, incontinence and enuresis.

TABLE II.

CYSTOSCOPIC AND SURGICAL FINDINGS

Kidneys	*Cases*
Essential hematuria	13
Posttraumatic hematuria	1
Stone-forming kidney	5
Pyelonephritis	11
Pyonephrosis	14
Genito-urinary tuberculosis	7
Hydronephrosis	12
Ptosis	4
Tumors of the kidney	4
Postoperative deformity	1
Extrarenal tumor	2
Anomalies of kidney and ureter	4

Prostate	*Cases*
Prostatitis	15
Hyper-prostate	26

Bladder	*Cases*
Cystitis	33
Trigonitis	7
Contracted bladder	1
Diverticulum of bladder	6
Tumors of the bladder	13
Vesico-vaginal fistula	1
Enuresis, no lesion	1
Cord bladder	2
Trabeculated bladder	2
Deformity from extra-vesical pressure	3

Urethra	*Cases*
Urethritis	15
Urethral stricture	9
Relaxed urethral sphincter	2

FIGURE 1

Sheet 3. X-RAY REFERRING CARD

Name—A. B. Charlton. *No.* A345678

Date—11-24-22. *Referred by Dr.* White. *Sect.* Black

Part to be rayed—Kidney, ureters and bladder.

(Use separate cards for K. U. B., Chest, Bone, Stomach and Colon).

On account of—Pain, right renal, radiating down the thigh. (Be brief and confine remarks to this space.)

Report—Multiple small shadows in the right kidney area. Phleboliths on the left. M.

REFERRED FOR X-RAY OF KIDNEYS

Please present this envelope at desk A, 2nd floor, Clinic Building, at 8:00 A.M. Tuesday.

Instructions to Patient—

At 5:00 P. M. take two ounces of Castor Oil.

Do not eat supper or breakfast other than a cup of tea or coffee.

At 7 A. M., with a fountain syringe, take rectal injection of warm soap suds until water returns clean.

(Oil and syringe can be obtained at Weber & Judd Co.'s Drug Store on ground floor, Clinic Building.)

Name—A. B. Charlton.

Physician—White. C. H. W. P.

Fig. 1—Roentgenography in the examination of the urinary tract.

INDICATIONS FOR THE ROENTGENOLOGIC INVESTIGATION OF THE URINARY TRACT

Braasch, in 1921, in his presidential address before the American Urological Association, concisely summed up the clinical data, other than that frankly suggestive of involvement of the urinary tract, that would indicate investigation roentgenographically. In brief, these indications, as noted by him, are: (1) a history of previous hematuria or pyuria, even though urinalysis is negative for the time being; (2) pus or blood cells in the urine, even though no other symptoms or physical data are suggestive of involvement of the urinary tract; (3) any tumor in the upper lateral abdominal quadrant or suprapubic area, or (4) a history of abdominal pain without definite evidence of disease in the intra-abdominal organs. He mentioned conditions which are commonly a source of confusion in diagnosis such as: (1) lesions with radiation of pain to the renal or suprapubic areas; (2) coincident lesions occurring in abdominal organs other than the bladder or kidneys, with the presence of pathologic elements in the urine; (3) abdominal lesions with a history of previous urinary symptoms; (4) doubtful sources of continued increase in temperature, particularly with a previous history of indefinite urinary symptoms, or with a few pus cells in the urine; (5) hepatic and appendiceal lesions with radiation of pain into the renal area, and (6) definite intra-abdominal lesions with evidence of coincident disease in the urinary tract.

These conditions and the lesions of the spine which I have mentioned as often being associated with suggestive urinary findings, constitute a considerable number of cases in which investigation of the urinary tract often is suggested, and account in part for the large percentage (67.4) of negative findings in this series. Moreover, all patients in the Clinic who are referred for cystoscopic examination have had a routine preliminary roentgenographic investigation of the urinary tract.

TECHNIQUE

The patients are given a referring card (Fig. 1) on which is the name and registration number of the patient with a brief note concerning the condition that suggested the examination, and are instructed regarding the preliminary preparation. This card is placed in an envelope on which are printed the instructions (so that they may be referred to) and also the number of the desk to which the patient will report with the day and hour and the name of the patient and the referring physician. The

instructions are to take 60 c.c. of castor oil at 5 o'clock, to abstain from supper and breakfast, other than fluids, and to take rectal injections in the morning until the discharge returns clear. Four roentgenograms, 20 by 25 cm., (Fig. 2) are made of each patient, without intensifying screens, one of each kidney area, one of the ureteral area and one of the pelvic and bladder area, the roentgenograms overlapping slightly. The roentgenograms are taken with the patient on the table in the recumbent position, with the arms at the sides, and the knees resting over an A shaped board that is hinged to allow adjustment to the height of the individual patient. This position allows maximal relaxation of the abdominal muscles. A cone is used which gives an average distance of 62.5 cm. from target to plate, and on the end of this cone is an aluminum compression cap with a diameter of 12.5 cm. In making the roentgenograms of the kidney the cone is brought down immediately below the costal margin, in about the nipple line, as far as the patient can comfortably bear, and the carriage locked. After locking, the cone is tilted up under the costal margin to a varying degree according to the thickness of the patient. For the third roentgenogram the cone is brought straight down in the middle line, about half way between the umbilicus and the symphysis pubis; for the fourth the cone is brought down just above the symphysis pubis, and, after locking the carriage, the cone is tilted with the cap pointing toward the coccyx. We use plates because they are more convenient for our present organization; when films can be used with intensifying screens, equally good results are obtained with less exposure, but our experience has been that artefacts are more common in films, and the screens must be kept flawless at all times to avoid confusing shadows. We prefer single roentgenograms of each area made with the compression cap rather than attempt to cover both areas of a kidney on one roentgenogram by any method. A standard type Coolidge tube, of medium focus, is used with a setting varying from 50 to 60 kv., according to the thickness of the patient, 30 to 40 ma. and four to eight seconds. To avoid contact of the patient's knees with the high tension wire a bakelite shield is placed below the glass bowl of the tube stand (Fig. 3).

When the roentgenologic findings suggest it, the patient is referred to the Section on Urology. As each patient reports to this section, whether the findings have been positive or negative, all the roentgenograms made of that patient are placed on the view box of the section so that the findings may be checked by the urologic consultants. The Section on Urology has its own roentgen-ray apparatus with an overhead installation so that it is possible to make roentgenograms in the examining rooms. At present a portable tube stand is taken from room to room as required, but arrangements are under way to install a tube stand on each table (Fig. 4), as one already in operation, carrying a 30 ma. radiator tube with fine focus, has given excellent results. Twenty-five by thirty cm. duplitized films with double intensifying screens are now used for pyelograms. The equipment and technique are similar to that already described, the time being shortened, of course, by the screens. Three pyelograms are made, the first with the table tilted in the Trendelenburg position; the second, with the table in the horizontal, and the third with the table in the reverse Trendelenburg position. The complete urinary tract is included in the three pyelograms. Pyelograms are only made on one side, sufficient time being allowed for evidence of reaction before they are made on the other side. Sodium bromide solution (15 per cent) is injected by the syringe pressure method very slowly and until the patient experiences a feeling of fulness or pain in the region of the kidney. If pain is experienced with a very small quantity, the withdrawal of the catheter for a short distance will sometimes allow continuation of the injected material without distress. Before making the lower pyelogram of the series the pelvis of the kidney is drained, the catheter is withdrawn from the kidney, and the lower ureter reinjected as the third exposure is being made. Opaque catheters are used if the passage of the catheter has been obstructed, and if the solution has failed to pass a given point in a previous examination. They are also used in the examination for certain types of shadows in the region of the ureter, two exposures with the tube at widely separated angles or stereoscopic films being made to define the relation of the shadow to the ureter. In certain types of anomaly, such as reduplication of the renal pelves or ureters and

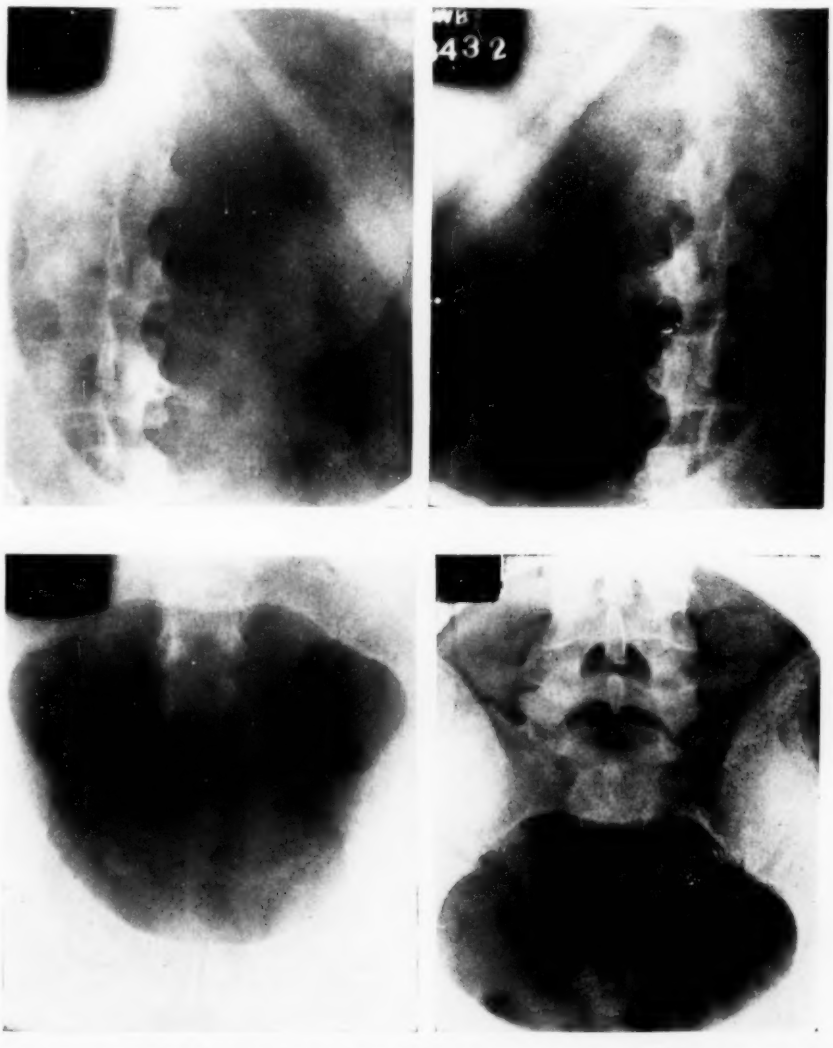


Fig. 2—Four areas included in the routine examination of the kidney, ureter and bladder.

horseshoe kidney, the opaque catheter is useful; it is sometimes coiled in the sac of a diverticulum in the bladder to gain information as to the size.

Cystograms are made by injecting the bladder with emulsion of silver iodid (5 per cent) and making two oblique views, one from the right and one from the left, with the tube angled twenty degrees laterally and toward the bladder, the compression cone resting just above the symphysis pubis. These oblique views will often show diverticula or cellules that would be missed by any other method. The bladder is then emptied and a straight view is taken over the bladder area; in many patients the injection will remain in the diverticula and valuable information will be afforded as to the size, the number and location of these, that cannot always be gained by the lateral views.

Fig. 3—The patient in position on the table with the A shaped board under the knees. The bakelite shield prevents contact of the knees with the high tension wires.

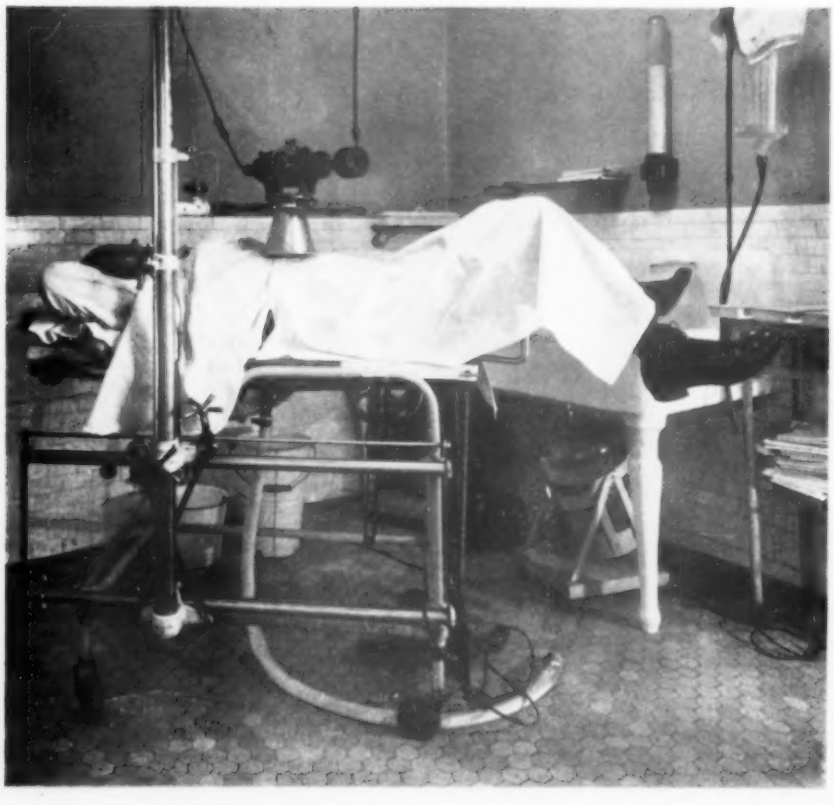


Fig. 4—The tube stand attached to the urologic examining table.

Urethrograms are made by placing the patient on the table with the left leg lying horizontally, the right leg elevated over the vertical stirrup, the pelvis tilted to an angle of approximately twenty degrees and the right thigh rotated slightly outward. The compression cone is brought down over the symphysis pubis. The urethra is injected by the gravity method, the container at a height of five to six feet, with a solution of sodium bromid (15 per cent) or by the syringe pressure method, using an emulsion of silver iodid (5 per cent), the exposure being made synchronously with the injection in both methods.

Prostatic calculi may occasionally be obscured by the bones of the pubic arch; these can be brought out by placing the patient in the prone position on the film and making an exposure with the compression cone over the anus, the ray being directed forward by angling the tube about twenty degrees.

For the last three years roentgenoscopy has been used with considerable success to assist the surgeons in locating and removing stones from the kidney. Prior to the observation the roentgenologist wears goggles of smoked glass or remains in a dark room for sufficient time to acquire dark-accomodation and retinal perception. A portable unit of the type that may be operated from an ordinary lamp socket is brought as near the operating table as possible, and after the kidney has been delivered from the wound the rays are focused through a small diaphragm so that they will fall through the kidney on the fluoroscopic screen. A hooded screen is held in the left hand of the roentgenologist, who makes the observation and with a metal rod, held in the right hand, accurately locates and guides the surgeon to the shadow. The exposure required is short; in the majority of cases it is little more than a flash.

Summary

In the one thousand cases studied, a total of 75 calculi were found by cystoscopic and surgical examination; 41 in the kidney, 24 in the ureter, and 10 in the bladder. The Section on Roentgenology reported 37 of the 41 in the kidney, 14 of the 24 in the ureter, and 6 of the 10 in the bladder. Thirty-one shadows diagnosed from the roentgenograms in the kidney area, 24 in the ureteral area, and 3 in the bladder area, as calculi or suggestive of

calculi, were ruled out or were not found at cystoscopic examination. Six of 10 calculi found in the ureters had been reported by the Section on Roentgenology as phleboliths. Phleboliths were reported in 376 patients. Shadows were often seen in the roentgenograms of areas embracing the urinary tract which were not seen in subsequent rerays of the same areas. Eliminating the rare passing of a stone, the conclusion must be that these shadows were cast by small concretions or particles of insoluble material in the bowel. Small areas of calcification in the abdominal glands cast shadows very suggestive of calculus. We have seen several cases in which small warts on the skin have cast shadows which were difficult to distinguish from calculi. Roentgenologic evidence, therefore, cannot be accepted as final, but must be checked by urologic investigation and correlated with the clinical evidence.

Measurements on Two American Deep Therapy Machines, With Special Reference to the Duane Method*

GEORGE E. PFAHLER, M. D.
Honorary Fellow of the Radiological Society of North America
Philadelphia

THIS brief paper must be regarded as a preliminary report. My object in presenting it is to call attention, (1) to the great importance of making measurements and making them frequently; (2) to a very valuable method, if not the most valuable method of making measurements; (3) to present some concrete data that will be helpful to some who may not yet have had the opportunity of measuring the output of their deep therapy machines.

As I have expressed myself before, I am fearful of the outcome of the use of these powerful high voltage machines when placed in the hands of untrained and inexperienced men. I have heard the same opinion expressed in Germany during the past summer, and yet some of these machines have been in use there for six or seven years. At first, however, these machines in Germany were used only in the universities, where they were under the control of experienced clinical radiologists and trained physicists. The contributions that come from great institutions such as those at Erlangen, Frankfurt, etc., in Germany, and Stockholm in Sweden have been most helpful to all the world. They have demonstrated superior results, and enthusiasm has become very great in Europe as well as in America. As a result high voltage machines are being bought and are being used by untrained men, and without sufficient study and control.

Unless the radiation treatment is undertaken with due consideration as to its applicability in the individual cases; unless it is planned so as to do as little harm as possible to the healthy tissues and yet be sufficiently destructive to the malignant disease, and unless the radiation is carefully measured so as to do no harm by using too much, or too little, the excellent progress which has been made will go for naught and fear on the part of the laity and condemnation on the part of the profession will again retard progress in this most important branch of medicine.

In Europe, careful measurements with the ionization chamber, or iontoquantimeters of various types, are made of each tube and each machine once each week. A half day is usually given up to this work, or a physicist makes the measurements at odd times when the machine is not being used clinically. This is good, but it would be better if such measurements could be made daily or even before each treatment. With the iontoquantimeters this is not practical, because of the time consumed, because of the cumbersome apparatus and arrangements, and because of the undue exposure of the operator.

Not only should the quantity of radiation be measured, but the quality as indicated by the wave-length of the radiation is of equal importance. Both the quantity and quality of radiation differ with different types of apparatus of different makes and involving different principles, and they differ even with the same make. I have two ten-inch machines of the same make which with the same parallel spark length and the same milliamperage differ by 15 per cent in the quantity of radiaton when measured by the ionization chamber and when both are running as nearly perfectly as is possible. Therefore, while formulae giving spark length, milliamperes, time, distance and filter are valuable, one must not be too dogmatic as to their exact value.

Fortunately Professor Duane, one of the Honorary Fellows of this Society, has developed for us a method of measuring the wave-length, which is practical and can be used by any member of this Society in his practical work, and in this way he can know definitely the quality of radiation being used. This method [1, 2, 3] has been described by Professor Duane in three papers read before the American Roentgen Ray Society at Cleveland in 1914, Atlantic City in 1922, and at Los Angeles in 1922, in which papers he described the progress made. The method consists in the measurement of the fraction of the radiation that passes through a given thickness of copper or aluminum. A curve has been published [2] giving the effective wave-length which determines the fraction of radiation that will pass through a given thickness of aluminum or copper. The fraction of the radiation that passes through the filter may be measured either by the photographic method or by the ionization method.

Professor Duane has also developed an ionization chamber which can be used for measuring the quantity of radiation which passes through copper or aluminum and thus one can determine the effective wave-length as indicated above. It can also be used for measuring the total quantity of radiation which is applied to the patient.

The ionization chamber (Fig. 1) is connected with a delicate galvanometer of the d'Arsonval type (Figs. 2, 3 and 4). Both of mine now measure one twenty-eight billionth of an ampere. The ionization chamber is standardized in terms of a certain unit of radiation. This unit of x-radiation is of such intensity that it passes one electrostatic unit of current in each cubic centimeter of the air through which the beam of rays passes.

The standard cell when connected with the galvanometer will give a reading on the scale corresponding to one electrostatic unit of radiation or a definite percentage of such a unit. For instance, in one of my outfits the standard cell gives a reading of one full unit. In the other the outfit is more sensitive and the cell gives a reading of only 0.2 of a unit.

One electrostatic unit of radiation indicates the amount of radiation which will ionize each cubic centimeter of air in the beam of rays so that it will permit the passage of one electrostatic unit

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 7, 1922.

of current. An electrostatic unit is defined as that quantity of electricity which raises a sphere of a radius of 1 cm. to the unit of potential, that is, 300 volts. According to Kohlrausch, it is expressed with a small "e". One electrostatic unit of current equals one electrostatic unit of charge per second. The number of electrostatic units of current multiplied by the number of seconds equals the number of electrostatic units of charge in the period of time.

Therefore, the number of electrostatic units of radiation (indicated by a capital letter E, as suggested by Professor Duane) if multiplied by the number of seconds during which the radiation is applied equals the corresponding number of small "e" as indicated by Professor Friedrich.

Professor Duane has expressed to me privately that the number of "e" units as published in Professor Friedrich's book should be multiplied by ten, or that a cipher should be added. At least he is of the opinion that radiation measured by the Friedrich method should give 1700 "e" where 170 "e" is indicated, etc. If this reading is given, then the Duane method and the Friedrich method give absolute units that correspond fairly well in their biological effect, and one should be able to interpret one value into the other.

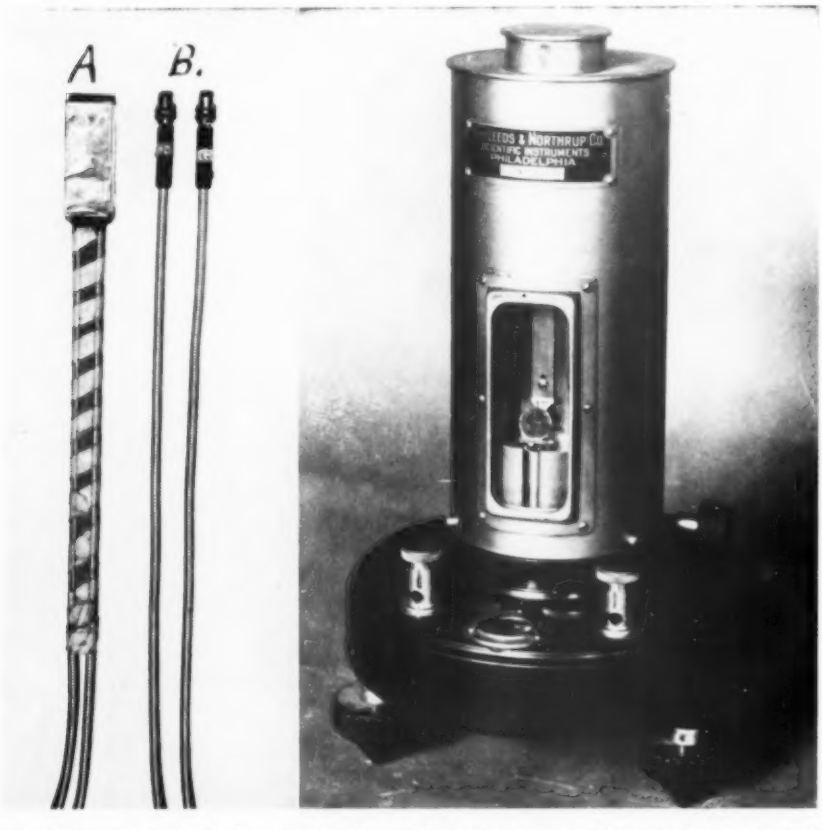
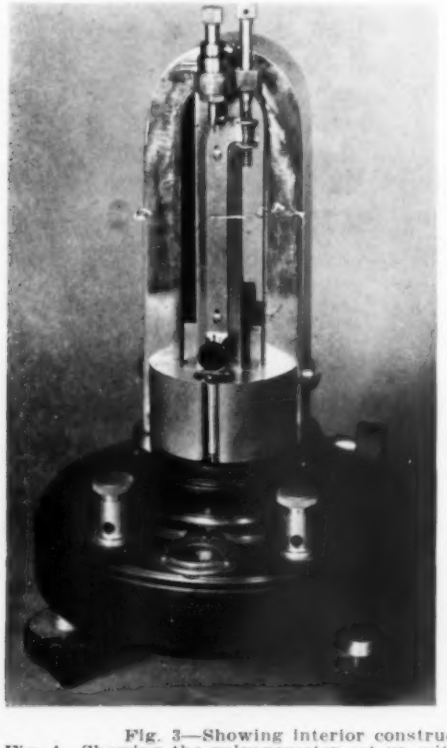


Fig. 1—Showing the ionization chamber "A", and the plugs "B", which are inserted into the sockets in any room containing a machine to be measured.
Fig. 2—Showing the galvanometer without the reflecting mirrors and the scale.



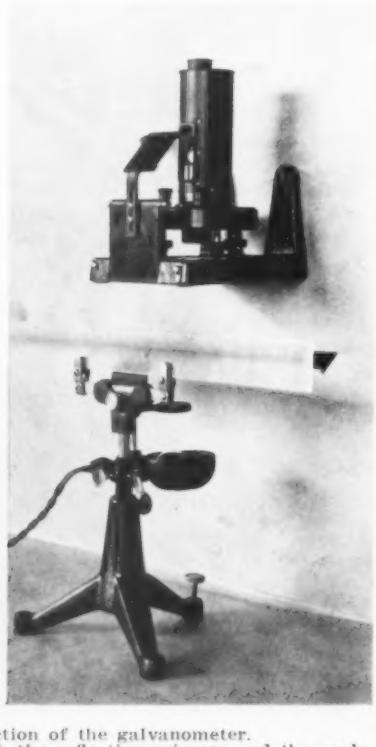


Fig. 3—Showing interior construction of the galvanometer.
Fig. 4—Showing the galvanometer set up with the reflecting mirrors and the scale. The galvanometer should be at least one meter above the scale.

Practical Applications of the Duane Method

With the outfit properly installed in practical work, one makes a test as follows: (1) Note the presence of any leakage by connecting the galvanometer in the circuit with both the standard cell and the ionization chamber out of the circuits. (2) Connect the standard cells into the circuit and take note of the number of millimeters that the indicator moves on the scale and thereby the number of millimeters that indicate one electrostatic unit of radiation. (3) Disconnect the standard cell and note that the indicator returns to the starting point. (4) Connect the ionization chamber in circuit and note no leakage (no movement of the indicator on the scale). (5) Place the ionization chamber in the beam of rays to be measured and note the number of millimeters of movement from the starting point. (6) The number of millimeters of movement of the indicator on the scale when the ionization chamber is in the circuit used as the numerator, and that of the standard cell used as the denominator will indicate the number, or fraction, of electrostatic units of radiation at the time of reading. All of these steps can be taken within five minutes. (7) Granting that the radiation is uniform and constant, then the fraction of E.S.U.R., as measured in electrostatic units of current, indicated by "E" multiplied by electrostatic units of charge or the number of seconds during which the radiation is effective gives the number of "e" given in any treatment.

In a similar way one can measure the fraction of radiation passing through a millimeter of copper and obtain the wave length used, by the scale given in

Figure 5. Then one can measure the output of the tube and apparatus before beginning treatment, so as to know whether it is up to the standard. During the treatment one can simply place the ionization chamber in the beam of rays and note that the radiation is or is not uniform. One can also place the ionization chamber on the opposite side of the part being rayed and note how much radiation comes through. One can also place the ionization chamber in a phantom and make actual measurements under varying conditions.

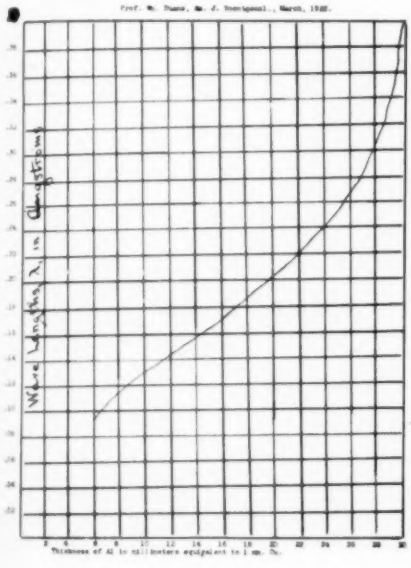


Fig. 5

It was found more convenient to measure wave-lengths by adding 0.5 mm. of copper to the filter which is left in place during the treatment, than to use a millimeter of copper. Therefore, Professor Duane has prepared a scale for direct reading on this basis. He first carefully measured the supposedly 0.5 mm. of copper which I was using as a filter, and measured it exactly. It was found to be 0.48 mm. This is a copper filter obtained from the Victor Electric Company about April, 1922. On the basis of measuring the rays which pass through 0.48 mm. of copper he prepared a scale for direct reading (Fig. 7).

In practical work, one places the ionization chamber about 10 cm. beyond the filter of whatever kind one is using (0.48 mm. Cu plus 1mm. Al) with the voltage and milliamperage constant, and at the working standard one reads the number of millimeters of movement of the indicator on this scale. Then the second layer of 0.48 copper is added and likewise covered by the 1 mm. aluminum and a second reading is made. The first record through 0.48 copper plus 1 mm. aluminum is the denominator of a fraction and the second reading through 0.48 mm. Cu + 0.48 mm. Cu + 1 mm. Al is the numerator, which, when reduced to percentage can be applied to the scale, and the wave-length recorded. This should not take over five minutes and involves no personal exposure to the rays.

With the above method the lower voltage machines can also be measured, both as to their output and to the wave-length. The effective wave-length with a nine-inch parallel spark between points and with 6 mm. aluminum is about 0.23 Angstroms, while with the higher voltage machines and 200 kv. the wave-length is approximately 0.17 Angstroms, when filtered through 0.48 mm.

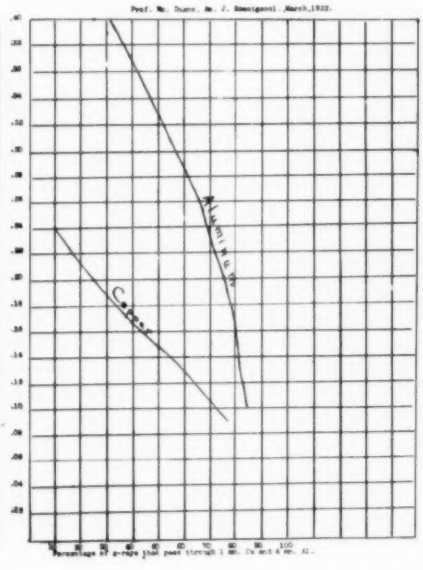


Fig. 6

Cu and 1 mm. Al as indicated above.

Much experience will be needed until the biological values can be established, but with the above wave-length, 0.17 Angstroms, the erythema dose is between 1700 (?) e and 2300 (?) e. We will probably find that the quantity of radiation as measured by "e" units will vary with the wave length. Certainly we can draw no conclusions on this point until we have had more experience in the practical application of these methods.

Under these conditions and by these methods we have measured the International Machine and the Reiber Booster now in use in my offices.

THE INTERNATIONAL MACHINE

With a voltage of 200,000, 4 milliamperes, at a distance of 62 cm., with a field 16 by 20 cm., and a filter of 2 mm. glass, 1 mm. copper, and 1 mm. aluminum, the indicator moved to a point 27.75 beyond zero when one electrostatic unit of radiation (as determined by the standard cell) corresponded to 92 mm. on the scale and

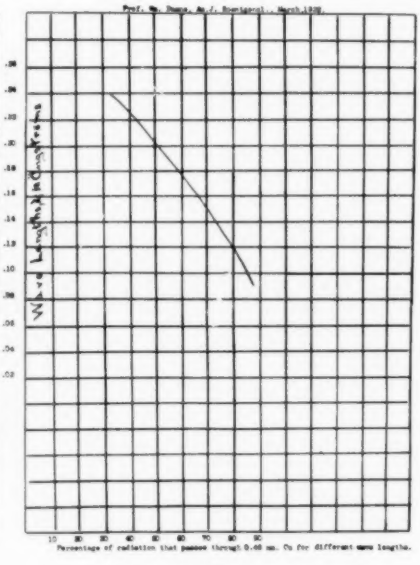


Fig. 7

when the effective wave length measured 0.165 A.

Under like conditions with the Rieber Booster, but running with 210,000 volts instead of 200,000, there was measured on the scale 23.13 mm., or 83 per cent of the radiation given with the International. Therefore, when one makes allowances for the voltage, the Rieber machine is about 20 to 25 per cent less efficient when working under like conditions. This does not condemn the Rieber Booster, for the tube seems

FIGURE 8

Cm. Depth	Mm. on Scale	E. S. U.	Per Cent	Loss in Tissue
0	37	.4000	100	. . .
1	34	.3700	92	8
2	31	.3400	85	7
3	28.75	.3125	78	7
4	26	.2861	71	7
5	23.57	.2562	64	7
6	21	.2285	57	7
7	18.57	.2019	50	7
8	16.37	.1760	44	6
9	14	.1532	38	6
10	12	.1300	32	5
11	10.75	.1175	28	4
12	9.03	.0982	24	4
13	8.28	.0895	21	3
14	7.14	.776	19	2
15	6	.0652	17	2

Fig. 8—**International Machine, October 3, 1922:** Distance 62 cm. Filter: 1 mm. Cu + 2 mm. glass + 1 mm. Al. Field: 16x20 cm. 1 E.S.U.R. = 92 mm. on scale. Voltage 200,000, 4 ma. No water, 30 E.S.U.R. under water.

FIGURE 9

Cm. Depth	Mm. on Scale	E.S.U.R.	Per Cent E.D.	Loss	Time E.D.
0	33.20	.3334	100	0	118 min(113)
1	31.61	.3327	95	5	
2	28.44	.30	86	9	
3	25.72	.27	77	9	
4	22.72	.2391	68	9	
5	20.11	.2117	60	8	
6	17.50	.1842	52.5	7.5	
7	15.44	.1625	46.5	6	
8	13.66	.1438	41	5.5	
9	11.72	.1233	35.5	5.5	
10	10.33	.1087	31	4.5	
11	9	.0937	27	4	
12	7.77	.0818	23	4	
13	6.55	.0690	19.5	3.5	
14	5.37	.0565	16	3.5	
15	4.66	.049	14	2	

Fig. 9—**Rieber Machine, October 21, 1922:** Distance 62 cm. Filter: 2 mm. glass + 1 mm. Cu + 1 mm. Al. Phantom water 25x25x20 cm. Field: 12x16 cm. 1 E.S.U.R. = 95 mm. on scale. Kv. 210 (Equals 105% of 200 kv.), 4 ma. No. water = 24/95 E.S.U.R. = 0.25. Water phantom adds 38%.

12x16 cm. = 33 min. = 100% = E.D. 118 min. { 10 cm. = 31% / 15 cm. = 14%

25x25 cm. = 35 mm. = 105% = E.D. 112 min. { 10 cm. = 37% / 15 cm. = 17%

16x20 cm. = 34 mm. = 102% = E.D. 115 min. { 10 cm. = 25% / 15 cm. = 12%

FIGURE 10

Cm. Depth	Mm. on Scale	E.S.U.	Per Cent	Absorption
0	60.43	.6498	100	..
1	54.80	.5892	91	9
2	50.40	.5419	83	8
3	46.20	.4964	75	8
4	41.00	.4401	67	8
5	35.66	.3834	59	8
6	31.00	.3333	52	7
7	27.20	.2903	45	7
8	23.40	.2516	39	6
9	20.20	.2172	33	6
10	17.50	.1882	28	5
11	15.20	.1634	24	4
12	13	.1396	20	4
13	11	.1183	17	3
14	9.40	.1011	15	2
15	8	.860	13	2

Fig. 10—**International Machine, September 22, 1922:** Distance 62 cm. Filter: 2 mm. glass + 0.5 mm. Cu + 1 mm. Al under 20 cm. water. Field: 12x16 cm. 1 E.S.U.R. = 93 mm. on scale. Voltage 200,000, 4 ma.

to take the current much more easily for some reason, and I feel certain that we can increase the voltage or the milliamperage sufficiently to bring the total radiation values to an equal amount.

It does illustrate, however, that one cannot simply speak of voltage, milliamperage, etc., and be sure that the total radiation is the same when using similar factors.

Both Dr. Bachem and myself found similar differences in the lower voltage machines, amounting to from 15 to 25 per cent, and yet we made our measurements by different methods. So, too, by the Duane method, I have found that there was an improvement of from 10 to 15 per cent in efficiency of radiation output when the uneven mica separators in the commutator were dressed.

Phantom Measurements

(Figures 6, 7, 8 and 9)

Probably the most interesting measurements from a practical standpoint are those made in a water phantom. For this purpose we use an aluminum tank 25 by 25 by 25 cm., the aluminum being 1 mm. in thickness. The tank was filled with water to a depth of 20 cm. This will duplicate the average conditions found in a patient whose abdomen we treat.

We found that the addition of this water phanton increases the radiation 38 per cent in the surface dose as compared with no phantom, the other conditions remaining the same. At a depth of 10 cm. with the International machine running at 200 kv., 4 ma., 62 cm. distance, a 16 by 20 field, filter 1 mm. Cu plus 2 mm. glass plus 1 mm. Al, we obtain 32 per cent of the surface dose. Under like conditions the Rieber Booster gave 31 per cent at a depth of 10 cm. This is very much less than is indicated by the Dessauer charts, or by Dr. Bachem's measurements. Dr. Bachem measured the International with 1 mm. Cu plus 2 mm. glass at a distance of 50 cm., 200 kv. and 4 ma. and he found 41 per cent of the surface dose at a depth of 10 cm. This percentage was obtained by calculation based upon the coefficient of absorption of water. It seems that he and Dessauer are therefore ignoring the effect of the secondary radiation on the surface dose. If I ignore this effect and take the radiation as measured independently of the body or water phantom, 24/95 E.S.U.R. as 100 per cent, then the depth value 12/95 will be 50 per cent of the surface dose at 62 cm. This will then be in excess of their measurements. I believe, however, that this is not correct and that we have no right to ignore the effect of the secondary radiation on the surface, any more than we would ignore its effect on the depth dose.

When 0.5 mm. Cu is used as filter instead of 1.01 mm. Cu, one obtains, with the International, 28 per cent of the surface dose at a depth of 10 cm., distance 62 cm.; and with the Rieber Booster 26 per cent of the surface dose at a depth of 10 cm. with a target surface distance of 42 cm.

Influence of the Size of the Fields on the Surface Dose

Another interesting observation was the effect of the size of the portal of entry upon the surface dose. We have heard much about the effect of the size of the field or portal of entry upon the depth dose, but I can recall no mention of a similar effect upon the surface dose; yet we should have expected this had we given it thought before. The body when radiated sends secondary radiations to the surface just as it does to the depth.

In measurements made upon the Rieber Booster, with the water phantom as above, at 62 cm. distance, 210 kv., 4 ma., 1 mm. Cu plus 2 mm. glass plus 1 mm. Al the effect of the size of the field is as follows:

Size of Fields in Cm.	Percentage	Erythema Dose	Intensity at Depth 10 Cm.
8x12	90%	130 min.	25% of surface intensity
12x16	100%	118 min.	31% " " "
16x20	102%	115 min.	33% " " "
25x25	105%	112 min.	37% " " "

With similar conditions, but with 0.5 Cu filter instead of 1.0 Cu and at 42 cm. distance instead of 62 cm. the Rieber Booster gives:

Size of Fields in Cm.	At Surface	Erythema Dose	Intensity at Depth 10 Cm.
8x12	76%	62 min.	26%
12x16	100%	47 min.	26%
16x20	105%	45 min.	30%
25x25	114.5%	41 min.	34.5%

FIGURE 11

Cm. Depth	Mm. on Scale	E.S.U.R.	Per Cent	Absorption	Time.
0	76.00	.8000	100	..	47 min.
1	66.20	.6968	87	13	..
2	58.60	.6168	77	10	..
3	53	.5577	70	7	..
4	46.48	.4842	60	10	..
5	40.50	.4263	53	7	..
6	35.50	.3737	47	6	..
7	30.60	.3231	40	7	..
8	26.80	.2821	35	5	..
9	22.60	.2379	30	5	..
10	19.70	.2073	26	4	..
11	16.70	.1758	22	4	..
12	14.10	.1484	18	4	..
13	11.80	.1242	14	4	..
14	9.60	.1010	12	2	..
15	7.40	.0779	10	2	..

Fig. 11—**Rieber Machine, October 21, 1922:** Distance 42 cm. Filter 0.5 Cu + 2.5 mat. + 1 mm. Al. Fields: 12x16 cm.; 20x25x25 cm. water. 1 E.S.U.R. = 95 mm. on scale. Kv. 210, 4 ma.

12x16 = 76 mm. = 100% { 47 min. = E.D. 100% ; 10 cm. = 26% ; 15 cm. = 10% }

25x25 = 87 mm. = 114.5% { 41 min. E.D. 100% ; 10 cm. deep = 34.5% ; 15 cm. deep = 16% }

8x12 = 76% { E.D. = 62 min. ; 10 cm. = 26% ; 15 cm. = 10% } { 58 min. ; 15 mm. ; 6 min. }

16x20 = 105% { E.D. = 45 min. ; 10 cm. = 30% ; 15 cm. = 12.5% } { 80 mm. ; 34 mm. ; 10 mm. }

Distance 42 cm. 12x16 cm. No cushion = 78 mm. = 100%
Distance 42 cm. 12x16 cm. Mattress 25 cm. = 76 mm. = 97.5%
Mattress absorbs 2.5%

Unfortunately, this whole method of measurement is still in process of development for practical use. We have had to make modifications to eliminate leakage, and there has been much difficulty with the galvanometer. This galvanometer is so delicate that the small suspended mirror dances whenever a heavy wagon passes on the street, and on two occasions the filament supporting the mirror has been broken. In one instance it was broken within 48 hours after being in place, and before any current was passed through it by us. Other repairs have had to be made on three occasions. However, these are difficulties which are to be expected in the development of a new method and they will be overcome. As a whole, it impresses me as one of the most valuable advancements that has been made for practical use.

It is these difficulties that have prevented me from making more observations. Therefore, I am drawing no conclusions at the present time.

References

1. Duane: 1914.

2. Duane: Roentgen Rays of Short Wave Lengths and Their Requirements. Am. J. Roentgenol. March, 1922, and July, 1922.

3. Duane: The "Caldwell Lectures," Proceedings of the American Roentgen Ray Society at Its Annual Meeting at Los Angeles, September, 1922. Am. J. Roentgenol, December, 1922.

X-Ray Treatment of Tumors*

E. L. JENKINSON, M. D.
Roentgenologist to St. Lukes Hospital, St. Joseph Hospital, Evanston General Hospital
Chicago

DURING the past eleven months some three hundred cases of malignancy involving various parts of the body have been treated by the writer, using a voltage of 200,000. These three hundred cases included early and late malignant conditions of the breast, uterus, pancreas, urinary bladder, stomach, lungs, esophagus, bones and mediastinum.

In some cases the response has been very favorable, while in others no improvement has been noted. It seems that if any benefit is to be derived it usually follows the initial series. In our experience, when treatment is scattered over a period of at least a week patients have much less general reaction than when subjected to the intensive method and the series completed in one day. The general discomfort, nausea and vomiting that usually follows the intensive method is of very little consequence when the series is divided into smaller doses spread over a week or ten days.

In treating malignancy, we have tried to consider each case individually, getting away as much as possible from a routine method. Each case presents some distinct features which should be carefully considered before treatment is started. It has been our plan to have the patients in the hospital twenty-four hours beforehand. A complete physical examination is made and the blood is thoroughly investigated. The night before treatment a cleansing enema is given. The administration of one dram of soda bicarbonate in a glass of cold water three times a day during treatment is the usual procedure. Patients are required to fast six hours before treatment, and no solid food is given for three hours afterward.

A careful estimate is made of the depth of the lesion, as well as a study of its anatomical relations. In dealing with localized lesions every effort is made to avoid normal structures as much as possible. In the presence of general carcinomatosis, this becomes practically impossible; in such cases, a general irradiation of the entire part is indicated.

It has been extremely gratifying to observe improvement in patients with spinal metastasis, secondary to carcinoma of the breast. The following cases will serve as illustrations:

Case No. 1: This patient was a woman thirty years of age, operated on five months previously. At the time of treatment there was extensive metastasis into the dorsolumbar spine and ribs. Owing to the severe pain in the dorsal spine an opiate was necessary before she could be moved to the x-ray department. The patient was suffering from a complete paraplegia, with retention of urine and loss of control of the bowels, and because of her condition only the dorsal surface of the chest and abdomen was radiated. Since the patient was unable to change her position, the dose was kept well below the point of skin reaction, so as to avoid the complications incident to bed sores. Four months have elapsed since the last treatment and she is now able to

*—Read at the Annual Meeting of the Radiological Society of North America, Dec. 6, 1922.

walk with the aid of a cane, and suffers practically no pain. The course of treatment was distributed over a period of three weeks. At the end of the first week she was able to move her toes, and catheterization of the bladder was no longer necessary.

The second case is that of a woman of 50, operated on four years ago for carcinoma of the breast, with extensive metastasis involving the entire spine. At the time of treatment she was developing cord symptoms and having severe pain in the dorsal and lumbar regions. The treatment was more thorough than in the first case, both the dorsal and ventral surfaces of the thorax and abdomen being radiated. It has been five months since the last treatment, and the process has been held in abeyance. During those five months, she has gained fifteen pounds in weight, now attends to her own housework, and is apparently quite well.

In pulmonary metastasis following primary breast cancer very little has been accomplished, even in a palliative way. The patients seem to become progressively worse, with no diminution in the amount of pain. After treatment a hacking cough develops and patients complain of tightness in the chest, accompanied by a burning sensation. The larger the dose, the more profound is the general reaction. Some ten cases have been treated, using both large and small doses, delivered in from two to fourteen days. The results have been essentially the same. However, the general reaction seems more severe when the entire dose is crowded into a period of two days. The nodules in the lungs are very resistant, and the patient's general condition shows no improvement. For weeks following treatment there is a general loss of ambition, accompanied by severe pain in both lungs with great difficulty in breathing.

In secondary sarcoma of the lungs, temporary relief can be obtained by the use of higher voltage. The nodules seem to become smaller, and in some instances entirely disappear. Accompanying the diminution in size of the nodules there is concomitant improvement in the general health, and in many instances the pain entirely disappears. These patients seem to do better when treated with small doses at frequent intervals, and the general reaction is practically negligible.

Some two years ago, I was called upon to treat a woman 30 years of age, with metastatic sarcoma of the lungs, secondary to sarcoma of the ischium, microscopically confirmed. Roentgenograms showed a definite lesion involving the right ischium. Invasion of the bone cortex was definitely established. In both lungs there were many nodules from one to four centimeters in diameter. During the previous three months she had lost thirty pounds in weight and frequent administration of morphine was necessary to control pain. The ischium and lungs were treated for three months by the older methods then employed, using a voltage equivalent to a nine-inch spark gap with 6 mm. Al as a filter. Nevertheless, the patient's condition became steadily worse. The technique was then changed; the voltage was increased to 160,000 filtered through 0.5 mm. Cu. With the above mentioned factors, half hour sessions were given at weekly intervals, and in the course of a month, the patient's general condition seemed to have improved. During the following six months, there was a gradual improvement with a gain in weight of some forty pounds. The pain was kept under control, the morphine was discontinued, and the nodules in the lungs became a great deal smaller. This scheme of treatment was continued for the next eighteen months and the patient remained quite well until the first of November, 1921. Then severe pain in the chest developed, accompanied by rapid loss in strength, confining her to bed and she died during the second week of December. In this case, the x-ray certainly controlled the pain, and it seems reasonable to believe, greatly prolonged life.

On March 8, 1922, there was referred for treatment a young man 27 years of age, with sarcoma of the lung, secondary to sarcoma of the testicle. When operated on three months previously, roentgenograms had revealed no metastasis in the lungs. At the time of treatment, the left pleural cavity contained a large quantity of fluid, practically obliterating the entire left chest. This had been aspirated several times, and bloody fluid removed, but the cavity refilled rapidly. During the following week the patient's chest was radiated anteriorly and posteriorly, receiving a total of 1200 ma. min. at 200 kilovolts with 1 mm. Cu and 1 mm. Al as a filter. Following the initial series, the pleural sac was again aspirated, and a large nodule involving the lower lobe of the left lung was then discernible. On March 25th, the patient was discharged from the hospital, and returned to his home in Michigan, where he remained for the following month. During this time there seemed to be no increase in the amount of fluid in the pleural cavity. The patient returned to the hospital for further treatment, on April 27th. Roentgenograms then showed no fluid in the pleural cavity, and diminution in the size of the nodule. The chest was again radiated, giving one thousand ma. min. For the following four weeks the patient's condition seemed to improve, and there was a general feeling of well being. He had no pain, and respiration was quite normal. On May 26th it was deemed necessary to give further treatment; in the left supraclavicular space there was a mass about the size of a lemon, which had developed during the previous week. Under treatment, this tumor responded readily, and in one week had decreased to the size of a hickory nut. The chest examination at this time seemed quite encouraging; no fluid was present in the left pleural sac, and the nodule in the lung was very much smaller. During the last course of treatment the patient complained at various times of severe pain in the head; this became progressively worse during the following month and morphine was necessary to produce sleep. During the first week of July the patient went into coma and died one week later. No autopsy was obtained. However, death was thought to be due to cerebral metastasis. In this case also it would seem as if great benefit was derived from the x-rays. After one course of treatment the fluid in the chest did not reappear, the pain was negligible, and the nodules greatly diminished in size.

Three cases of carcinoma of the stomach are included in this series. One of the cases had been explored at the Mayo Clinic nine months previously, and an inoperable carcinoma of the pylorus was encountered. The patient has received two series of x-ray treatments, of moderate dosage, without any systemic reaction. Since the first treatment, eight months ago, he has gained twenty-five pounds in weight and he is now symptom free. The blood is practically normal, with 4,500,000 reds and 95 per cent hemoglobin. At this time, November 20th, the patient has regained his normal weight, and has resumed his occupation as a printer.

The second case has not done so well, due to the extreme radiation sickness which followed each treatment. It has been impossible to finish the course started two months ago. After each treatment the patient complained of excessive vomiting, and for a period of three or four days afterwards was unable to retain even liquids. There was rapid loss of weight and strength. On this account it was deemed advisable to discontinue treatment.

The third case, a man of 60, with a small carcinoma of the pylorus, was referred for treatment preparatory to resection. The treatment was distributed over a period of ten days, through three portals of entry, viz., anteriorly, posteriorly and right laterally, using moderate doses. At no time during treatment did the patient have either systemic re-

action or gastro-intestinal disturbance. Three months have elapsed since the treatment; his general condition is much improved; his appetite is quite normal and he has gained ten pounds in weight. He has been so impressed with this improvement that he has declined operation.

In some twenty cases of carcinoma of the urinary bladder, the results have been uniformly good. The patients have been subjected to large doses and seem to have experienced no serious difficulty. During treatment, pain in the bladder may be increased and there is usually a frequent desire to urinate, accompanied by an irritating tenesmus. These symptoms may continue for a week following the treatment, and then gradually subside. In one case recently treated, the symptoms have been greatly aggravated. Besides a more frequent desire to urinate, there has been pain and hemorrhage. The exacerbation might well be due to frequent instrumentation and the instillation of silver during treatment. The use of strong solutions on a bladder mucosa already irritated and congested by the x-ray might well account for such unfavorable symptoms. Of late it has been our practice to ask the urologist to withhold instrumentation and instillation until the x-ray treatment is completed.

Two cases treated ten months ago, showing bladder ulcerations cystoscopically (microscopically malignant), have remained well. Eight weeks after the initial treatment the urologist was unable to find any evidence of malignancy. He remarked that he would have been unable to make a positive diagnosis had he not known the patient had had a malignant process.

In mediastinal tumor immediate improvement is the rule. The tumor mass becomes smaller, pressure symptoms subside, and the engorged blood vessels rapidly disappear. Three mediastinal tumors have been treated, and all have been greatly improved. Two of these patients are at present symptom-free, and the mediastinal mass is no longer demonstrable.

The third case has now been treated for over a year and her general condition is quite alarming. The tumor, however, has remained small, but there has not been a concomitant improvement in her general condition. When first treated the mass extended well beyond the sternum and measured twelve centimeters in transverse diameter. The patient was unable to lie prone, dyspnea was pronounced, and the skin was quite cyanotic. The blood vessels over the anterior chest wall were greatly engorged because of circulatory obstruction within the thorax.

After one course of treatment at a peak voltage of 140,000 the tumor mass was greatly reduced, and the superficial vascular engorgement disappeared. This improvement continued for one month, when the tumor again began to grow and the superficial circulation again had to relieve the obstructed deep circulation. Another course of treatment was given at the same voltage, but the mass grew rapidly larger. Frequent examinations were made during the three weeks following the second series, and each time the tumor seemed larger. During the second course, left pleurisy with effusion developed. The patient's general condition became progressively worse and she was referred to Dr. Case, who at that time had a transformer capable of delivering 200,000 volts. Immediately after the third series, the patient's condition rapidly improved. The tumor mass decreased in size, and at the end of two months was no longer discernible; the pleural effusion was gradually absorbed. Four months after treatment at Battle Creek, the patient developed dysphagia, which, on fluoroscopic examination, was found to be due to a tumor pressing on the esophagus. A fourth series was instituted, and the difficulty in swallowing rapidly subsided. During these four courses of x-ray treatment the tumor had been kept quite well under control, but the patient's general condition had become weaker. There had been gradual loss of appetite and marked loss of weight, even under forced feeding the patient was unable to recover lost ground. A month ago she presented herself for further treatment, but after careful examination and consultation we were forced to decline. Is it not possible that in this case we may be dealing with a cachexia, probably due to x-rays? The tumor mass has been controlled, but in its destruction, the patient's general condition has suffered. In the other two cases mentioned the amount of radiation was comparatively small, and the tumor mass was controlled without sacrificing the general condition of the patient.

Therefore, in the treatment of mediastinal tumors, we feel that it is advisable to administer small doses, having the patient return at frequent intervals for careful examination. If on examination the tumor seems to be progressing, a small amount of x-ray may be administered. In the case above reported there is one point of unusual interest, in view of what has been written about the effects of x-rays upon the pleura and lungs. During treatment, the patient developed pleurisy with effusion, which after still more intensive radiation at higher voltage was gradually absorbed.

During the past eleven months, one case of advanced carcinoma of the pancreas has been radiated. When treatment was started the pancreas was greatly enlarged and there was metastasis to the left supraclavicular space. The patient was cachectic and greatly emaciated, and very little was expected even in a palliative way. During the first course the pancreas and chest, including the supraclavicular spaces, were radiated anteriorly and posteriorly. During treatment the patient had considerable nausea and vomiting, at times so marked that treatment had to be interrupted. For six months after the first series the patient's general condition improved and the tumor became smaller. On June 7th she returned for a second course; she said she was much better, and was then quite comfortable and hopeful. The second series was distributed over a period of ten days, and the dose somewhat increased. The blood at this time showed 3,370,000 reds, 5,400 whites and 64 per cent hemoglobin. During this treatment the patient was practically free from any nausea and vomiting and was able to take treatment daily. On June 14th, examination of the stool showed a positive Weber, but this finding was not repeated on successive examinations. On June 17th she returned home and for four weeks seemed to gradually improve. On July 10th she was suddenly seized with sharp abdominal pain, and died in a short time. No autopsy was obtained. The physician in charge attributed her death to the x-ray treatment. It is probably quite natural in such cases for the physician to blame the x-rays, however, it is hardly fair to condemn the method, especially in the presence of such extensive involvement. Death was inevitable, and the most that could be expected was prolongation of life. This, we feel, was accomplished. When the patient presented herself for treatment, she was told we could promise nothing. She replied that if she might live until the first of June, to see her son graduate, she would be quite satisfied.

In dealing with carcinoma of the cervix uteri we have had the advantages of close cooperation with the gynecologists. Results in early cases have been quite satisfactory, while in more advanced cases, with extensive involvement, there has been some improvement in general health and the symptoms have been held in abeyance for a time at least. In a few cases diathermy was used in conjunction with x-rays. One case classified as inoperable and hopeless, was twice diathermized and later subjected to x-ray therapy. Six months have elapsed since the last treatment, and the patient has gained forty-five

pounds in weight. She now claims to feel like a girl of fifteen. The discharge has disappeared and the cervical stump seems quite normal. No bimanually palpable masses can be felt. It seems useless to attempt the treatment of uterine carcinoma by x-rays alone, thus subjecting the bowel and urinary bladder to intensive x-ray crossfire, when by the local application of radium or the use of diathermy the local lesion can be attacked directly. The judicious use of x-rays is indicated in treating adjacent lymph glands and malignant foci too distant to have been reached by radium or diathermy.

Too short a period has elapsed to enable one to state whether or not the improvement in selected cases will be permanent. However, we can say that the immediate results have been better than we anticipated, and certainly surpass anything heretofore accomplished. The improvement in carcinoma of the uterus is probably due to the accessible location of the uterus. The depth being about ten centimeters in the average woman, a great deal of scattered radiation is utilized. The average absorption in the first ten centimeters of tissue is about fifty per cent. It can be readily seen that by using four portals of entry the depth dose can be built well up beyond one hundred per cent of the erythema dose.

In the treatment of bone sarcoma very little progress has been observed. Pain can be controlled, but the effect wears off rapidly and in the course of ten days following radiation the pain again becomes very severe. Practically no regression of the tumor has been evident, in fact, in most of our cases the tumor mass seems to have progressed steadily. In trying to establish a satisfactory technique several methods have been used. In some cases, small doses repeated at short intervals have been given, while in others large doses at one sitting. The results, however, have been uniformly discouraging.

In sarcoma of soft tissues the results have been only fair. Patients not previously operated on seem to do better than those subjected to surgery. A patient with a large round-cell sarcoma involving the fascia of the right thigh was given two courses of treatment. Five months after the first course the mass had diminished from the size of a grapefruit to that of a walnut. The patient's general condition is now very satisfactory and he has resumed his former occupation. Radiographic examination of the lungs and bones shows no evidence of metastasis.

Another patient with a sarcoma of mixed type but with small round cells predominating, had been previously operated on, but the operation had been followed by rapid recurrence. The patient was referred to me on July 6th.

The tumor was located on the posterior aspect of the upper third of the left thigh, but the femur was not involved. The mass was about the size of an orange. The blood on that date showed 4,300,000 red cells, 4,400 whites, and 90 per cent hemoglobin. The differential count was quite normal. The tumor was radiated through four fields, giving in all 1700 ma. min. at 200,000 volts, at a distance of 56 cm. using a filter of 1 mm. Cu. and 1 mm. Al. For two months the patient's condition seemed to improve; pain was alleviated and the growth became smaller. A roentgenogram of the chest at this time showed no evidence of metasatasis. The patient returned for further treatment September 4th, and 2800 ma. min. were given through four fields, using the above mentioned factors. For a month following treatment the condition seemed under control and the tumor was appreciably smaller. On November 10th, two months after the second course, the mass began to grow very rapidly, and severe pain in the abdomen developed. X-ray examination of the lungs showed no definite metastatic nodules. On January 3rd, the patient died of peritonitis. Autopsy revealed a perforation of the ileum. No metastasis was found in the lungs or abdominal viscera.

In treating carcinoma of the breast, at high voltages, we have noted very little improvement over the older technique. However, we do not believe that the x-rays are at fault, but rather that our method of administration is not correct. In breast carcinoma a technique similar to that used in carcinoma of deep structures is not applicable to comparatively superficial lesions. No one technique will apply to all cases, nor be applicable to all types of malignancy. The therapeutic value of x-rays depends upon the amount of rays absorbed by the tissues; therefore, the dose is the difference between the amount delivered to the skin and that which goes through the body. For example: If 100 per cent is delivered to the skin, and at a depth of five centimeters 60 per cent is delivered, the dose is, therefore, the difference between 60 and 100, or 40 per cent the amount absorbed in the five centimeters. Carcinoma of the breast is a comparatively superficial lesion, being located, as a rule, not more than three inches from the skin surface. We have found (using beef for the experiment) that only thirty per cent of the x-ray beam, measured by the iontoquantimeter, is absorbed in the first two and one-half inches. With the technique commonly used throughout the United States, the greater part of the x-ray beam is absorbed in the deeper normal tissues. The majority of roentgenologists have been treating carcinoma of the breast through two fields, viz., anteriorly and posteriorly. In treating posteriorly, the target-skin distance has been increased to seventy-five centimeters. Even with the increase in distance, only about 20 per cent of the skin dose is delivered to the area of pathology. Even when the treatment is given from two directions it can readily be seen that the radiation absorbed by the tumor mass is well below 60 per cent. With the above technique, we have observed in a great many cases, multiple recurrences immediately under the skin. Of late, we have tried by the use of paraffin, bread dough and sheeting, to convert comparatively superficial lesions into deeper ones. By this method it is possible to increase the absorption in the first three inches of tissue to about forty per cent. The scattered radiation given off by such artificial media is also utilized. In experimental work it has been found that ten per cent of the x-ray beam is absorbed in five inches of sheeting. By using bread dough mixed with some antiseptic preparation, which can be easily moulded to the breast, the tumor mass can be readily converted into a deep lesion.

It has been contended by many roentgenologists that the lungs should be treated in all cases of carcinoma of the breast, because of potential involvement. This view seems too broad, and in many cases of breast cancer, pulmonary metastasis cannot be demonstrated. I recently saw a patient who had been operated upon twenty-one years ago for carcinoma of the breast. It does not seem probable that this patient had metastasis to the lungs at the time of the operation. One can recall many cases well fifteen years after operation. It must again be emphasized that each case should be treated as a special entity; no routine technique is adaptable to all cases. Having used the higher voltage in a great many cases of carcinoma of the breast with discouraging results, I have found it advisable to return to a medium voltage. Inasmuch as the pathological process is quite superficial, it seems reasonable to believe that the x-rays of softer quality, and absorbable in the first three inches, will produce better results. I have recently adopted a technique similar to that used by Dr. Pfahler, using 125,000 volts, filtered through 6 mm. Al and a target-skin distance of 15 inches. With these factors a distinct tanning can be produced in thirty minutes. The breast is divided into as many areas as possible, using the cross-fire method. Patients with cutaneous or subcutan-

eous recurrences are, in some cases, treated with a seven inch gap, without filtration. The technical details are made to conform to the individual case.

I have recently treated a patient with a pituitary tumor. At the time there was optic atrophy, with practically complete loss of vision. The patient complained of severe headache and nausea recurring at frequent intervals. Roentgenologic examination of the skull revealed complete destruction of the clinoid processes, and erosion of the base of the sella. In the region of the pituitary fossa there was an indefinite shadow which was thought to be cast by a tumor. The patient came for x-ray treatment August 29th. A comparatively small dose was given at 200 kilovolts, through the right side of the head, directly over the pituitary gland. The two following days, small doses were given through the left side of the skull, and through the roof of the mouth, directed to the tumor. Immediately after treatment, there was considerable nausea and vomiting, and the pulse rate fell to sixty. These symptoms continued for two days, after which they subsided, and for a period of two months the patient felt well. When he returned for examination and treatment, late in October, the symtoms had reappeared, and he was anxious to have further treatment. At this time a larger dose was given through two fields over the right and left side of the skull. Following the treatment, the patient's condition became quite alarming. The pulse became unusually slow and irregular, and there was profuse projectile vomiting. This situation continued for a week and the patient was greatly weakened. The increase in dosage may well have accounted for the distressing symptoms; they may have been part of a reaction associated with inflammatory edema, and consequent increase in intracranial pressure. If we are to consider such symptoms at all seriously, it would seem advisable to avoid large doses in pituitary tumors, and the patient should be treated with small doses at frequent intervals.

Conclusion

1. In the majority of cases, even after very large doses, the blood count has remained practically normal; the changes noted usually occurred in the white cells. Immediately after treatment there is a rise in the white cell count, followed by leukopenia lasting about four weeks, and gradual return to normal. The lymphocytes seem more sensitive than the other types of cells. The hemoglobin has shown practically no change in the majority of cases. Patients with blood changes following therapy are usually of the advanced type, cachectic and emaciated. If during treatment such patients suffer from radiation sickness and are unable to take food and water there results dehydration and consequent blood changes. Out of three hundred cases we have found a white count below three thousand in only two. After a rest of five weeks, the counts returned to normal.

2. In all abdominal cases, careful examination of the stool for blood showed positive findings in five only.

3. Only in a small number of cases have we encountered severe diarrhea.

4. Experience has taught us that malignancy makes it impossible to give a definite prognosis, good or bad. Cases that seem hopeless are often greatly improved, while early cases may go on to a fatal termination, uninfluenced by the rays. The best course seems to be to avoid promising patients or relatives anything regarding improvement, even in cases that appear very favorable.

X-Rays and X-Ray Apparatus; An Elementary Course*

JOHN K. ROBERTSON, M. A.
Associate Professor of Physics, Queen's University
Kingston Canada

The Gas Bulb

48. The main features of the type of gas tube in most common use for either coil or transformer are illustrated in figure 49. C is the cathode, with face concave or cup-shaped, so that as noted in Section 45, the cathode rays are brought to a focus on the face of the target. From the focus spot x-rays spread out in all directions, passing through the whole half of the hemisphere in front of the plane M F M. Here it may be noted that when the current through a gas tube is in the right direction, the portion of the bulb in front of the plane M F M is usually strongly fluorescent, being separated from the remainder by a sharp line of demarcation. The target T forms the end of a long metal arm A, the anticathode, which by means of the connecting wire W, is in electrical contact with N, the anode. The anode N lies within a short side arm of the tube, and does not project into the main body of the tube. V is another side tube which carries a third electrode E, and is added for the purpose of regulating the gas pressure in the bulb. P represents a rubber tip covering the place at which the tube was sealed off from the exhaust pump after the initial exhaustion has been completed.

Regulation of the Vacuum

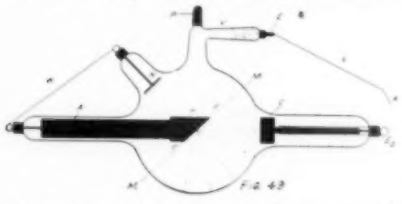
49. It will be seen later that the nature of the beam of x-rays leaving a tube depends both on the current, that is, the milliamperage (ma.) and on the voltage across its terminals (the back-up). An operator, therefore, must be able to control both the current and the voltage. Now, if the vacuum remains constant, the higher the voltage applied to a tube, the greater the current through it (see Sec. 52 below). There are cases, however, where an operator may wish to change to a *higher* voltage without altering the milliamperage, or possibly with even a smaller milliamperage. How can this be done? To understand the answer to that question, it is necessary to remember that the voltage required to maintain a given current through an ordinary vacuum tube varies with the pressure of the contained gas. If, therefore, by any means, the gas pressure in any x-ray bulb is altered, a different voltage will be required to pass the same current through it. If the vacuum is lowered (pressure increased), the resistance of the tube decreases or it becomes "softer." If the vacuum is raised, the tube runs "harder", that is, the resistance increases. A soft tube, therefore, is more conducting than a hard one.[1] Putting it in another way, a higher voltage, or a bigger back-up is necessary to maintain a certain milliamperage through a tube when it is hard than when it is soft.

The desired regulation of voltage and current may be obtained (1) by having a series of tubes, for example, one soft, one medium, one hard; (2) by altering the pressure of the gas in a single tube. The first method is to be preferred for tubes which will maintain a fairly constant vacuum (see Sec. 53 below). Since, however, vacuum changes in a tube are ultimately inevitable, method (2) must be used to some extent, even in the case of an outfit which includes a number of tubes.

50. But it is asked, how can one vary the pressure in a tube which is sealed and cut off from any connection with an exhaust pump? Such a variation is possible because all gas tubes are supplied with what are called

*—Received for publication March 19, 1923.

vacuum regulators. Reference will be made to three of these. (1) In the kind in most general use, a side arm, V, (Fig. 49) provided with an electrode



E, and containing some substance such as asbestos wool, charcoal, lime, etc., is sealed on to the tube. Such substances contain a certain amount of "adsorbed" gas, some of which is released when the substance is warmed. The usual method of warming the regulator consists in passing an electric discharge between the electrode E and one of the main terminals of the tube. For this reason, whenever a gas tube is used at any appreciable distance from a transformer or coil, three lead wires are invariably used. A glance at Figure 51 will show the reason for this. In this figure C and D represent the high tension terminals, while AC is a metal rod capable of being rotated about C, but normally in the position shown in the figure. When the x-ray switch is closed, the current passes through the tube circuit and the tube in the usual way. Suppose, however, that by means of a cord R attached to the rod AC, it is pulled aside to the dotted position until the end A touches B, a "binding post" on an insulated support. If, now, B is attached by means of a flexible conducting cord to E, the electrode of the vacuum regulator, it is evident that, on closing the x-ray switch with the rod in this position, the discharge passes through the tube from the vacuum electrode to the terminal E_2. As a result of such a discharge, the substance in the regulator is heated and a certain amount of gas (largely carbon dioxide and water vapour) liberated. As a rule, only a small quantity of gas is required and care must be exercised not to allow such a discharge to pass for any but the shortest intervals of time. If such a precaution is not taken, the pressure may be raised too much, and re-exhaustion of the tube may be necessary.

Occasionally the regulator is used in such a way that, if the tube becomes too hard when in operation, it is automatically softened. To accomplish this, the third wire is dispensed with and use is made of an adjustable flexible wire X (Fig. 49), permanently attached to the electrode E. Suppose this wire is set with its end A near one of the tube terminals, but at such a distance that no spark jumps across. It will be seen that (provided the distance A to E_2 is not too great), if the tube should harden appreciably when in operation, the higher voltage across the tube will cause a spark to jump this gap, thus sending a discharge through the regulator. Gas will then be liberated, the tube will be softened, the voltage across the tube will drop and sparking A to E_2 will cease.

The vacuum regulator we have been discussing is of use only in lowering the vacuum. Suppose the pressure in a tube is too high, how can it be reduced (that is, the vacuum *raised*)? This can be done to some extent in at least three different ways, (1) by operating the tube with small currents until it is quite hot, (2) by setting the tube aside for some length of time, (3) by cooling the vacuum regulator. As noted in Section 54 below, a tube hardens when in use because of the adsorption of gas by the glass walls, the metal electrodes and possibly the regulating substance itself. The hardening because of method (2) simply means that this absorbing process increases with time. In the case of regulators containing some hygroscopic substance such as asbestos packing, method (3) has been used with success by Levy and Mann[2]. These workers have shown that with such regulators, tubes may be conveniently hardened by cooling the regulator by means of an ethyl chloride spray. For exact details of using this method, which is extremely simple, the reader is referred to the original article. The method is based on two sound scientific principles. (a) Water vapor in an enclosed vessel will condense until it has the equilibrium pressure corresponding to the lowest temperature of any part of the vessel. In this case the regulator tube becomes coated with snow and ice. (b) The adsorption of gas, at least in the case of many substances, increases with decreasing temperature. Research workers when using apparatus in which a high vacuum is necessary, frequently attain the required low pressure by attaching to their apparatus a tube containing cocoanut charcoal immersed in liquid air. At the low temperature of liquid air the absorption of the charcoal is very great.

It is desirable, however, to have a tube too hard rather than too soft, for, as noted above, the remedy for too great softness is re-exhaustion.

In this connection attention may be called to an article by Mutscheller[3] in which he describes a gas tube with a somewhat new type of regulator. To begin with, use is made of a new substance which consists of a mixture of nitrides of metals such as thorium, aluminum, barium, etc., and, it is claimed, has the property not only of liberating nitrogen when warmed by a discharge in the usual way, but also of absorbing or "adsorbing" nitrogen from its surroundings. With such a substance, therefore, because of this adsorption, the tube on standing automatically returns to the hard state. On each occasion when it is desired to use the tube, it must be softened to the desired degree. To guard against over-softening a device is added, as a result of which, once a certain pressure has been attained in the bulb, the discharge instead of passing from the electrode through the substance, passes from the electrode to a metal cylinder surrounding the substance and then through the main part of the tube. For details, the reader is referred to the original article. In this tube, to which reference will again be made, it is well to note that the residual gas is nitrogen. For the original cut of Figure 52 an illustration of this tube, as well as for Figures 55 and 56 my thanks are due the Wappler Electric Company of New York.

THE PALLADIUM TUBE

(2) The metals palladium and, to some extent, platinum are porous to the gas hydrogen. Use is made of this property to regulate the vacuum in a gas tube. The device is extremely simple. Instead of the regulator just described the bulb has a side tube somewhat as illustrated in Figure 53. Through one end of this is sealed a palladium tube, with the end inside the bulb open, the end outside closed. To soften a tube with such a device all that is necessary is to place a small flame of burning hydrogen (illuminating gas will do) in contact with the closed end of the palladium tube. Hydrogen will then diffuse inside the bulb. If illuminating gas is used, in order to ensure an excess of hydrogen no air should be supplied the flame.

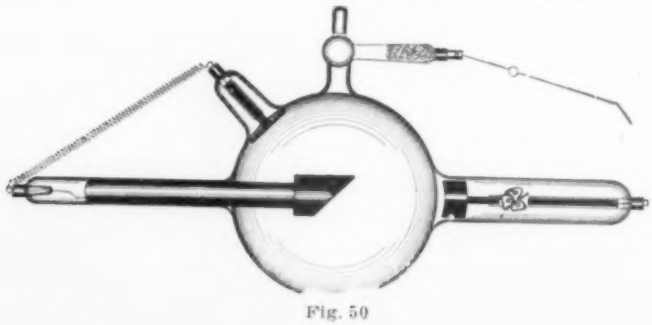


Fig. 50

A palladium tube may also be used to harden a tube, provided it contains hydrogen as the residual gas. To use it for this purpose the external portion of the tube must be warmed in an atmosphere *free from hydrogen*. In this connection reference may be made to the so-called Hydrex tube, which is provided with two palladium tubes, one (A) enclosed in a small bulb containing hydrogen at a pressure considerably greater than that within the x-ray tube itself; the other (B) open to the air. If A is heated, hydrogen passes into the bulb; if B is heated, hydrogen passes out.

The Bauer Valve

(3) This is a third device for softening a tube. By means of it small quantities of air from the surrounding atmosphere may be admitted to the tube. The principle will be understood by reference to Figure 54 (taken from Kaye's *X-Rays*). Connection between an unglazed porcelain tube and the outside air can only be established when the column of mercury, indicated by the black line, moves past P, the junction of the porcelain tube with the mercury column. Normally the air pressure in the chamber C is such that this connection is sealed. If, however, by means of a pneumatic pump (the bulb of a syringe might do), the mercury is forced past the junction, air from the ouside can enter the porcelain tube, and hence diffuse through its pores into the tube. To prevent the passage of mercury vapor into the x-ray bulb, the porcelain tube contains a packing of gold leaf. As the mercury quickly returns to its normal position, only small quantities of air are admitted at a time.

Rating the Vacuum

51. It will be evident that the terms hard and soft are very general ones. There must be a border line condition, for which one might describe a tube as "not very hard" or "not very soft." It is natural to ask, therefore, if there is not a more exact way of describing the resistance of a tube. It will be recalled that when one is dealing with conductors, such as ordinary wires, filament lamps, etc., their resistance is expressed as so many ohms. With such conductors it is found by experiment that if we take any given resistance, the current through it is always proportional to the voltage across its ends; that is to say, if we double the voltage, the current is doubled; triple the voltage the current is tripled, and so on. As a consequence of this experimental law (Ohm's Law), the number obtained by taking the ratio $\frac{\text{volts}}{\text{amperes}}$ is taken as a measure of the resistance of the conductor. For example, if, when 12 volts are applied to a conductor the current is 2 amperes, the resistance is $\frac{12}{2}$ or 6 ohms. [If 6 volts had been applied, the current would have been 1 ampere].

52. Is there any corresponding way of expressing the resistance (degree of hardness) of an x-ray tube? To answer that question, we must resort to experiment. Suppose, with tube vacuum as constant as possible, we vary the voltage across the tube and for each value note the corresponding current (ma.) through it. Do we find any simple relation between volts and milliamperes? According to the data given in Tables III and IV (a record of some results published by the Wappler Electric Company, and reproduced with their kind permission) there is an approximate law. In Table III, for example, it will be noted that the ratio $\frac{(\text{voltage})^2}{\text{ma.}}$ is approximately equal to 0.9 for all values of the current. This means that if the voltage be doubled, the current becomes four times as great; if trebled, the current will be nine times as great. In Table IV similar readings for a softer tube are given. In this case, the ratio $\frac{(\text{voltage})^2}{\text{ma.}} = 0.6$ approximately, and the same law holds roughly, double the voltage, the milliamperage is four-fold.

TABLE III.—TUBE A

Voltage (in inches gap)	Current (in ma.)	$\frac{(\text{inches})^2}{\text{gap}}$
6″	40	.90
5″	29	.86
4½″	23	.88
4″	17	.94
3″	10	.90

TABLE IV.—TUBE B

Voltage (in inches gap)	Current (in ma.)	$\frac{(\text{inches})^2}{\text{gap}}$
5″	40	.62
4″	27	.59
3½″	21	.58
3″	14	.64

The law, however, is not exact, although the figures do establish its approximate truth. Moreover, they show why it is possible to express the degree of hardness of a gas tube by a number, as has been done by the Wappler Electric Company. Tube A (Table III), for example, is said to have a 0.9 vacuum, Tube B (Table IV), a .62 vacuum. To illustrate once more, in this system a tube with a 0.4 vacuum, is one through which a current of 40 ma. is passed when the back-up is 4″.

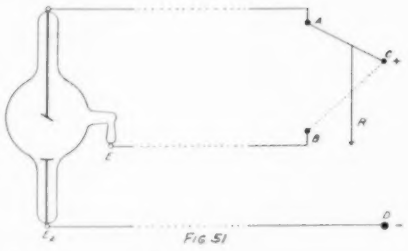


Fig. 51

$\left[\frac{4^2}{40} = .4\right]$. Such a tube is of medium hardness and suitable for all average work. If a tube is hardened so that a back-up of 6″ is required to pass 40 ma., the vacuum is now 0.9, that is $\frac{6^2}{40}$.

As a matter of practice, however, there is not much need for rating the vacuum. An operator soon knows by experience what voltage and milliamperage is required for the particular case in hand, and, will choose his tube accordingly or will regulate the vacuum until the proper combination has been obtained.

Constancy of the Vacuum

53. In radiography it is desirable and in treatment it is highly important that an x-ray bulb should maintain a given vacuum for some length of time. With a tube which has been properly handled, this is the case. When first used, gas is liable to be liberated from the electrodes of a new tube, and the vacuum alters. If, however, care is exercised to avoid initially the use of long exposures and heavy currents, the tube ultimately settles into what is called a "seasoned" condition. "Once a tube is seasoned it will maintain its vacuum and degree of hardness for long periods and may be used for hours daily" (Knox). For that reason it is desirable to have a range of tubes of varying degrees of hardness and to avoid as much as possible the use of the vacuum regulator. But the possession of a range of tubes, all maintaining a constant vacuum, is more or less an ideal state of affairs and vacuum regulators are indispensable. Here again we may refer to the tube with the regulator described by Mutscheller, which, is claimed, makes it possible to adjust a tube to conditions ranging from very soft to very hard. Moreover, once this tube has been set in a given state, a constant vacuum is maintained for all ordinary time intervals required in radiography.

Action of the Tube

54. A vacuum regulator is necessary for another and a very important reason. In the case of a tube which has been in use for some time, two things are observed: (1) the tube gradually

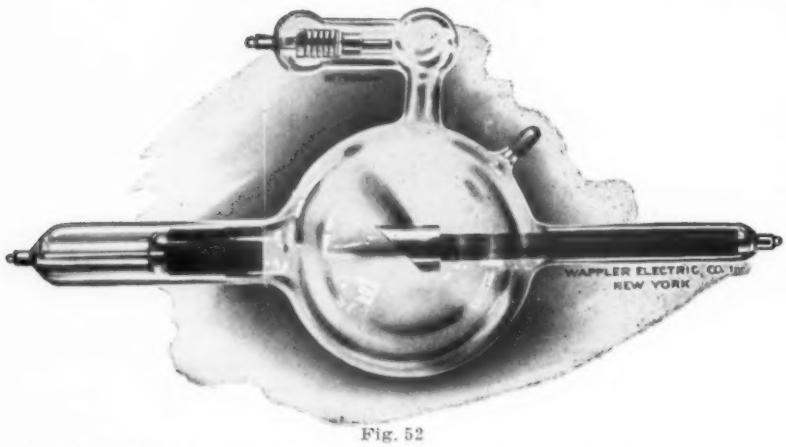


Fig. 52

runs harder; (2) the glass walls of the tube are gradually coated with a black metallic deposit which looks much the same as the black coating often seen on an old tungsten filament incandescent lamp. Now, this gradual hardening is due largely, if not altogether, to the absorption or adsorption of the residual gas by the walls and electrodes of the tube. After a time, therefore, it is absolutely necessary to use some means of letting a little gas in a tube.

The adsorption is increased by the presence of the metallic coating, and herein lies one reason why such blackening is undesirable and should be avoided as much as possible. Three other objections to the presence of blackening may be stated: (1) it increases the resistance of the tube; (2) sparking along the walls rather than through the gas is liable to take place; (3) the danger of puncture is increased. "Experiments in the laboratory have shown that a grounded metal wire can be brought up into contact with a clear bulb when the tube is operating, whereas with a tube having a metal deposit inside, such a wire must be moved away a number of inches to avoid puncturing the tube." (C. N. Moore, General Electric Company).

Causes of the Blackening of a Gas Tube

55. We can understand how best to minimize blackening by noting that it is the result of two causes, (1) the evaporation and disintegration of hot metals; (2) a cathode disintegration known as "sputtering." Sputtering consists of the ejection of metallic particles from the cathode. These particles are small pieces of metal and must not be confused with electrons.

In a good tube, therefore, blackening is minimized, (1) by choosing as metal for the cathode one which sputters a minimum amount; (2) by keeping the tube and especially the metal parts as cool as possible, and so preventing vaporization. Moreover, as the greater the current which is used, the more marked is each of these phenomena, obviously heavy currents should not be used any more than is necessary. In the actual construction of the bulb, however, means are taken to minimize the causes of blackening. These can best be explained by referring briefly to further details in connection with the actual construction of the tube.

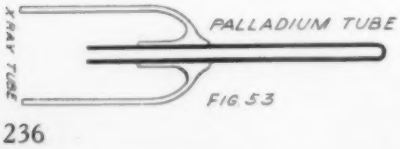


FIG 53

The Cathode

56. To obtain x-rays for good radiographs, as already noted, cathode rays must be focused at a small region on the face of the target. The focusing is done partly by the curved shape of the cathode, partly also because the walls of the glass and the layers of air adjacent to the electrode become negatively charged and exert a repulsive force on the negative rays. This force repels the cathode rays to the centre of the target, so that even with a plane cathode, a certain amount of focusing takes place. To some extent also the nature of the focusing depends on the gas pressure. Here it may be noted that it is not desirable to have the high tension transformer too near the tube, because the effect of the strong magnetic field on the cathode beam may be injurious to proper focusing.

The choice of the metal used for the cathode depends largely on the degree to which sputtering exists. Experiment has shown that tungsten, tantalum, and aluminum in comparison with metals such as platinum, silver, lead, sputter remarkably little. Aluminum, therefore, which is so readily obtained, is invariably used as the cathode. (To prevent sputtering from the wires connecting the cathode with the external electrode, these wires are sometimes encased in glass tubing).

The Anticathode

57. We have seen in the preceding chapter that a beam of cathode rays represents a considerable amount of energy. At the focal spot, where this energy is concentrated, enough heat may be developed to melt and so puncture the target. But, even if the face of the target is not punctured, the metal may be heated to such a degree that it easily vaporizes, and subsequently is deposited on the walls of the tube. Evidently it is desirable (1) to choose a metal for the target which has a high melting point; (2) to keep the target as cool as possible.

In Table V will be found numerical data relating to certain metals which are of interest to the x-ray worker.

It will be seen that platinum, which for several years was the metal used to the greatest extent as anticathode, is by no means the most satisfactory. Compare it with tungsten, for example. Its melting point, 1750°C., is little more than half that of tungsten, 3300°C. Moreover, platinum is one of the metals which sputters readily, whereas tungsten sputters but little. For this reason, should any inverse be present in the case of a platinum target tube, blackening would soon be pronounced. (During inverse the anticathode will act as cathode). In recent years, therefore, tungsten has been gradually replacing platinum, partly, perhaps largely, because of the research work of the General Electric Company, Schenectady, on the production of wrought tungsten.

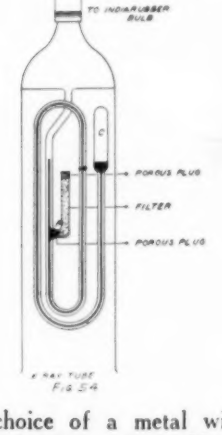


FIG 54

The choice of a metal with high melting point is not in itself sufficient to prevent vaporization. If no means are taken to conduct heat away from the focal spot, the temperature will steadily rise, and some volatilization will soon take place. A glance at the figures in the last column of Table V will show that evaporation of a metal may take place at temperatures considerably below the melting point. In a good anticathode, therefore, some means is used to prevent the temperature from rising quickly. This is done to some extent by using a heavy piece of metal as connecting link between the target and the external electrode of the anticathode. Copper, because of its high thermal conductivity, as well as its low specific heat is a suitable metal. Addi-

tional cooling is sometimes provided by attaching to the end of the anticathode outside the tube, thin sheets of metal which act as radiators of heat. (A good example of this is found in the radiator type of Coolidge tube, to be discussed in the next chapter).

Another means is found in the use of water cooled targets. In this case (see Fig. 55) the hollow anticathode is filled with water, which accordingly is directly in contact with the back of the target. Because of convection currents set up in the water or because of an actual flow of water, the temperature of the target may be kept below even 100°C., and practically all the evil effects of hot targets eliminated.

Output of X-Rays

58. Another important reason for using metals of high melting point is found in the fact that such metals are usually also of high atomic weight. Now, other conditions being the same, the intensity of a beam of x-rays emitted by a tube increases with the atomic weight, or, putting it in another way, is proportional to the atomic number (see Sec. 42). In this respect there is not much to choose between platinum, irridium, osmium, tungsten and tantalum, but any of these is markedly superior to nickel, for example.

Regarding this whole question of output, we may note one or two further points. If we look on an x-ray tube as a "machine" for the generation of what we call x-rays, it is remarkably inefficient. Only an extremely small fraction of the total electric energy supplied a tube is changed into the energy represented by the x-rays themselves. The intensity of the beam, however, is at least roughly *proportional* to the energy supplied the tube per second, or as noted in Section 21, to the product volts x milliamperes. By steadily increasing this product, the intensity of the x-ray beam steadily increases. There is, however, a limit to the energy (volts x milliamperes x time) which may be supplied a tube. This limit depends largely on the rate at which the temperature of the cathode rises. With a "fine focus" tube, for example, that is, in the case of one in which the cathode beam is focused to a small area, less energy can be supplied than with a broader focus tube. In the latter case, the intense heat generated at the focal spot is spread over a larger area. Again, the larger the tube, in general, the greater the amount of energy which may with safety be supplied it.

To sum up, every tube has a maximum allowable input of energy and an operator should always be extremely careful not to exceed this maximum. It would be a wise precaution if on every tube, this value were plainly marked. This would at least help to prevent the ruining of a tube which sometimes occurs at the very outset of its career.

The Auxiliary Anode

59. In almost all gas tubes, the anticathode is in electrical connection with an auxiliary anode (N, Fig. 49). Such an additional electrode is not necessary, and, to quote from Kaye's admirable book on x-rays, its "precise benefit is doubtful." Two or three points in connection with it, however, may be noted. A discharge passes with difficulty through a vacuum tube when the anode is within the dark space (see Sec. 44). Now, in the case of an x-ray tube, as we have already seen, exhaustion is continued until the dark space fills the whole body of the tube. If, therefore, no auxiliary anode were present, since the target is in the center of the tube, the discharge would pass with greater difficulty. Again we have seen that the old type of valve tube (Sec. 38) acts as a rectifier, because the less restricted electrode in a tube functions more readily as cathode. Accordingly, without the auxiliary anode, the anticathode (being less restricted), would tend to act as cathode and actually help to suppress current in the right direction. Finally, should inverse current be present, there is an advantage in having an auxiliary anode made of aluminum, which, as already noted, sputters an exceptionally small amount.

Danger of Inverse

60. In section 48 it was pointed out that when the tube current is in the right direction, the whole half of the bulb in front of the plane MFM (Fig. 49) is fluorescent and separated from the other half by a sharp line of demarcation. When the current is in the wrong direction, there is no such sharp line and the central portion of the tube is not divided into two well-defined halves. In this case, the glass in the region of the cathode exhibits fluorescence in a somewhat irregular fashion that may vary with the particular tube used. This fluorescence is the result of the impact on the walls of the tube of cathode rays sent from the target (the cathode during inverse) and may be looked on as a danger signal. It means that there will be an excess of heat developed at the regions where the fluorescence exists, with consequent possibility of a tube puncture. The x-ray switch should at once be opened or the loss of a tube may be the penalty.

The Residual Gas

61. In Section 50 reference has been made to a tube in which, because the residual gas is hydrogen, it is possible either to raise or to lower the vacuum by means of palladium tubes. Obviously in this tube, the residual gas must be hydrogen. In the same section, however, it was stated that the gases liberated from the ordinary vacuum regulators, are carbin dioxide and water vapour. Which gas, therefore, if any, is the most suitable? Is there any decided advantage in one over all the others? Consider, first, the question of constancy of vacuum. We have seen that, because of the adsorption of the residual gas by the walls of the tube, as well as by metal surfaces inside it, there is always a progressive hardening.

TABLE V.

Metal	Atomic Weight	Atomic Number	Melting Point	Thermal Conductivity	Specific Heat	Volatilization detectable at
Platinum	195.2	78	1750°C	0.17	.03	1200°C
Iridium	193.1	77	2290°C	0.17	.03	1400°C
Osmium	190.9	76	2700°C	0.17	.03	2300°C
Tungsten	184	74	3300°C	0.35	.03	1800°C
Tantalum	181.5	73	2900°C	0.12	.04	.....
Molybdenum	96	42	2500°C	....	.07	.....
Copper	63.6	29	1084°C	0.92	.09	.....
Nickel	58.7	28	1450°C	0.14	.10	.....

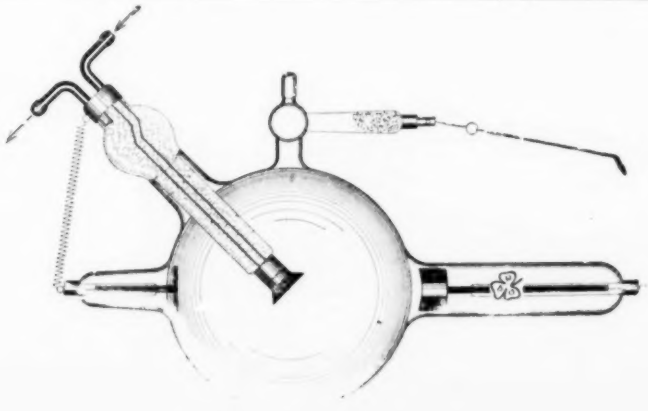


Fig. 55

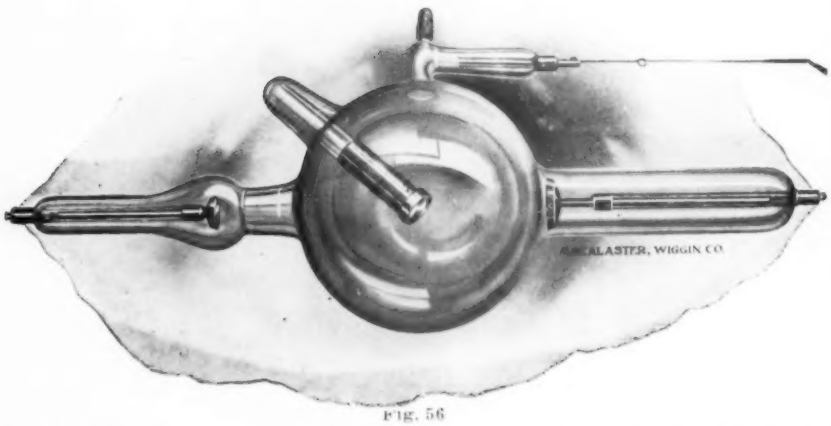


FIG. 56

Is this phenomenon more marked with some gases than others? A partial answer to that question is found in the research work of the General Electrical Company, of Schenectady, and in that of Mutscheller, of the Wappler Electric Company. The former work has shown that all gases are adsorbed by the glass walls of a tube, while oxygen and nitrogen combine with hot tungsten. The experiments of Mutscheller have shown that with the metals copper, iron and aluminum there is less absorption of nitrogen than of oxygen and hydrogen. He concludes, therefore, that nitrogen is the most suitable residual gas, and because of such experiments has designed the nitrogen tube with the vacuum regulator already described. In this tube, it will be recalled, the gas released by the regulating substance is nitrogen.

Again, according to Kaye, bulbs originally filled with hydrogen, nitrogen, and carbon dioxide show less sputtering than is the case with air and presumably oxygen. Moreover, volatilization is much less marked in the case of platinum, rhodium and iridium when oxygen is absent from the surrounding gas. For these reasons, therefore, it does not seem desirable to use air as the residual gas because of the large percentage of oxygen present. On the other hand, to quote Kaye once more, "for the same pressure a tube runs harder in hydrogen and still harder in carbon dioxide than in air" and "a tube rendered unsteady by the hardening effect of hydrogen may often be caused to run smoothly by letting in a little air."

To sum up, there does not seem to be overwhelming evidence in favor of the marked superiority of one gas over another, although something is to be said for nitrogen. Possibly the extent to which the Coolidge tube is replacing the gas tube is at least partly responsible for the lack of conclusive evidence on this point.

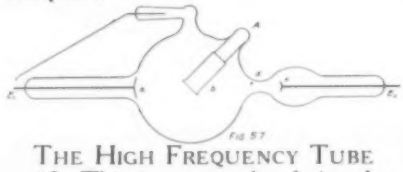


FIG. 57

THE HIGH FREQUENCY TUBE

62. This is a gas tube designed to operate on a high frequency outfit. Without going into details, we may note that with such apparatus an *alternating* high voltage (with high frequency) is available. The ordinary tube is therefore not suitable for use in such a case. In almost any catalogue, however, one may find a tube illustrated of the type shown in Figure 56 and Figure 57. This tube differs in two respects from the ordinary gas bulb; (1) the anticathode (A) has no external connection; (2) the end (c) of the electrode which functions as the anode is, behind a constriction (d). Now the question to be explained is this. When an alternating high voltage is applied directly to the terminals E_1 and E_2, why does current pass only when E_1 is the cathode? The reason is given in the words of Mr. C. N. Moore, of the Research Laboratory, General Electric Company, "During the half-wave when *a* is negative, the cathode stream from *a* impinges upon *b* producing x-rays, and the charge leaks off through the gas to *c*. When *c* is negative, there is no cathode stream from *c* because the constriction at *d* prevents bombardment of it by positive ions and the escape of electrons from the small side bulb. Thus, no current passes through the tube during this half-wave." In other words, this type of tube is its own rectifier.

63. In conclusion, it should be evident that, in buying a gas tube, the exact kind of apparatus with which it is to be used should always be stated. A high frequency tube, for example, is not meant for use with a transformer outfit. Moreover, even a tube most suitably chosen is liable to exhibit certain idiosyncrasies. The intelligent operation of any kind of tube is possible only by one who understands something of the nature of the passage of electricity through a gas. In the last two chapters of this course, the writer has tried to present the necessary fundamental principles of this branch of electricity. It would not be fitting if he concluded them without expressing his indebtedness to the authoritative book to which reference has already been made more than once, Major G. W. Kaye's *X-Rays*.

FOOTNOTES.

1—Later we shall see that the terms "hard" and "soft" are also applied to describe the character of the rays leaving a tube.

2—Levy and Mann: Am. J. Roentgenol. 8:112, March, 1921.

3—American J. Roentgenol. 7:261, May, 1920.

The Present Status of Radiation Therapy-With Case Reports*

J. THOMPSON STEVENS, M. D.
Montclair, N. J.

DURING the year of 1921 a great surgeon whom we all respect, Dr. John B. Deaver, is reported to have said, "Nothing can be looked for from radium in the treatment of cancer." Surgeons of equal prominence, and most physicians, agree that radiation therapy properly done is of great value in the management of malignancy. In this paper I shall try to search out the causes for Dr. Deaver's statement, and shall set forth as clearly as possible the necessary qualifications for proper radiation therapy.

I do not believe that we as radiotherapists can satisfactorily dismiss the questions that have been raised by saying, "That is from a surgical source."

Radium, properly used, is one of our very best agents in combating malignancy, but we must not depend upon it alone in all cases, nor must we expect it to do the impossible. It is to be regretted that radium is so easily applied. Men all over the country whose chief interest is in surgery or in some other branch of medicine are buying and using radium; they are as I have heard it stated, "getting into the radium game." It is next to impossible for any one to keep thoroughly up to date in both radiation therapy and surgery, or in any other branch of medicine. Present day radiotherapeutic methods have entered the stage of an exact science and any one of us who tries to keep thoroughly up to date will find little time for anything else. I am satisfied that if I, with little or no training, were suddenly to take up surgery that there would be immediate cause for criticism and I ask you whether under such circumstances surgery or I should be criticised?

When, using the correct dosage, we place radium within or upon a malignant growth we can expect a destruction of malignant cells within a radius of three centimeters only. This proven statement, it seems to me, indicates the reason for failures with radium alone. Beyond this radius of three centimeters any malignant cell struck by these radium rays will not be retarded or killed, much the same as removal of part of a malignant growth by means of the knife will not kill the malignancy. At the end of such treatment our patient is generally worse than before. Some of the malignant cells have received a partial dose of radium rays and have become more "adult in type," i. e., they become at least partially ray fast and further radiation does no good.

Some workers are using radium at great focal distances from the surface of the body so as to radiate the growth and its lymphatics, hoping that this with perhaps internal radiation in the form of needles placed directy into the growth will produce the desired results. Dr. Russell Boggs has said that it takes about 92 grams of radium to equal the radiation coming from a roentgen bulb working under proper treatment factors. With any such amounts of radium as any one in the world has, external radiation with radium in malignancy will be done only at tremendous time and expense and with generally unsatisfactory results. One exception to this rule is found in the treatment of metastatic nodules in the axilla following amputation of the breast, when the scar extends onto the arm in such a way as to prevent its being raised enough to allow the roentgen rays to be sent directly into the axilla. In such a case it is justifiable to use a radium pack in the axilla but better than this is to crossfire toward the axilla from every possible angle with the roentgen rays, and then to place radium needles directly into the nodules. Radium, however, is easy to use, we do not have to watch it constantly—all we have to do is to remember when to remove it from the patient's body.

It is my belief that our results in cancer will depend more upon our skill in using the roentgen rays, for here we have an unlimited supply of radiation, than it will depend upon the fact that we have one or more x-ray machines and large quantities of radium. With radium at its present price and limited production I believe that any improved results obtained from time to time will be the results of increased knowledge of the roentgen rays. Leaders in our work, Drs. Pfahler, Boggs, Schmitz, Tyler, etc., are not using radium alone in any case of malignancy except perhaps an occasional epithelioma. In my own laboratory radium is never used until after one full series of roentgen radiations have been completed. Almost daily, I believe, I see the value of this plan. I do not mean that I cure every patient who presents himself to me with cancer, but I do mean that the satisfactory results obtained by me are in the majority rather than in the minority. Many of the cases are past the stage where other methods can be looked to for help, and the results obtained in the majority of them clearly indicate that radiation therapy is of tremendous value in the management of malignancy. Satisfactory results will mean permanent cure in some cases, only palliation in others. So far as I know there is no physician, except the Great Physician, who has the power to cure every case of any disease that comes to his door.

Proper use of the roentgen rays does not consist in simply letting the rays play upon a certain part of the body until the alarm clock rings or until the door bell announces the arrival of another patient. When a patient is to have roentgen treatment he must be measured in every direction that the location of the disease will permit. The location of the growth, its depth from all surfaces, etc., must be known. A patient with one set of measurements cannot have the same treatment as another patient who has entirely different measurements, or one who has the disease in an entirely different part of his body. After measurements are completed, if the apparatus to be used has had its output and intensity in the various depths standardized, we can figure out on paper just how many doses or areas with certain treatment factors are necessary in order to deliver a "cancer dose." Then we are ready to start our treatments. We must watch the apparatus and patient constantly and we must expect expensive breakdowns at times. The entire roentgen technique is tedious and time consuming, we cannot practice surgery or some other branch of medicine and do roentgen therapy properly. I am sure that radium is so frequently used alone because roentgen therapy takes time and training which the busy physician cannot afford to give it. In my own case I have learned that even roentgen diagnosis and treatment cannot be mixed with entire satisfaction, unless one can have two separate staffs, one for therapy and one for diagnosis.

I have mentioned the fact that in my laboratory I never use radium locally until at least one full series of roentgen radiations has been completed. The point I wish to make especially is this, that almost to a man we are advising preoperative radiation. In my opinion preradium radiation is at least equally important. I am sure that the surrounding lymphatics and the primary focus

*—Read at the Midyear Meeting of the Radiological Society of North America, St. Louis, May 20, 1922.

of the disease itself are more in need of preparation by means of the roentgen rays preceding destruction by radium than preceding removal by surgery.

The surgical side of malignancy is of tremendous importance. No case of operable malignancy should escape operation and any case of inoperable malignancy that becomes operable under radiation therapy should likewise be operated. Even in operable cases, however, both preoperative and postoperative radiation therapy should be used. The preoperative treatments are of most importance because many of the cells are killed or destroyed, the lymphatics draining the area are more or less obliterated, thus tending to prevent metastasis; any transplanted malignant cell that is properly rayed will not produce a metastatic malignancy.

Electrothermic coagulation is a method of treating certain forms of new growths occurring in certain localities. Until recently it has not been very popular with many of us but lately it is justly becoming more popular. When possible it is good practice after preliminary roentgen radiation to remove local manifestations of disease by means of electrocoagulation. It has several advantages over any other method. At no time during the operation are the lymphatics or the blood vessels opened, for the same current that coagulates or destroys the other tissues seals the lymphatics and blood vessels. Because of the former action there is less chance for metastasis, and because of the latter the operation is bloodless. During the operation of electrocoagulation we must make sure that we destroy all the disease, i. e., we must see that coagulation extends well out into the healthy tissue; it should in fact begin in the healthy tissue, the diseased tissue being destroyed last. When coagulation is completed we may remove the diseased tissues by cutting them away, always keeping well within the coagulated area, or we may allow the whole mass to slough away itself. Electrocoagulation is one of the most efficient methods, if not the most efficient one, known today for removal of malignant tissue without subsequent recurrence or metastasis or both. This method is not particularly known for its power for beauty but in cancer we are dealing with questions of life and death. It is unfortunate that all localities affected by malignancy cannot be treated by this method. However, one is at once struck by a surprisingly good cosmetic result following so much destruction.

Electrocoagulation can be used to advantage in cancer of the bladder (suprapubic cystotomy), leukoplakia, cancer of the tongue, malignant tonsils and other oral pathology. Lately I have used the method for malignant tumor within the sigmoid colon, and for cancer of the cervix, etc. I believe it is the best method of treatment for malignant dermatitis caused by radium or roentgen rays. In this latter group of cases it is of course not preceded or followed by radiation.

In the above paper I have tried to show that radiation therapy should not be criticised until it is known just how the physical agents were used in a certain group of cases. If due consideration is given to the technique used, very often it will be found that the technique is at fault rather than the roentgen or radium rays. I know that a leading radiotherapist has in the past and still is obtaining generally entirely satisfactory results in Dr. Deaver's cases. Some of these results are miraculous and in nearly every case they are palliative to a degree such as can be obtained by no other means, opium not excepted. I know that Dr. Deaver is not criticising the results obtained by this operator.

Conclusions.

1. The largest group of cases that can be cured are the operable cases. These cases should be operated about two weeks after thorough roentgen treatment. Then postoperative radiation should be given.

2. The borderline cases, i. e., those that are just beginning to show evidence of metastasis, should be treated by radiation therapy, both the roentgen and radium rays being used. Should they become operable they should not be denied the advantage of operation. Some of these should result in cure and palliation will result in all.

3. Definitely inoperable cases should be treated with radiation therapy only, except the very few that become operable. The results with this group will not equal those of group two.

4. Hopeless cases should have the benefit of radiation therapy that they may discontinue the use of opium and that they may die a painless death.

5. Radium should not be used alone in any case of malignancy but should always be preceded and followed by the roentgen rays.

6. When judging radiotherapy, physicians and surgeons should always remember that many of the cases referred to the radiotherapist are those which have progressed so far that recovery through any method or combination of methods of treatment is impossible.

7. More cases in any group will be cured if combined methods of treatment are used whenever indicated.

Case Reports.

Case No. 1. Mr. J. K. Age 82 years. Patient of Dr. T. Paczkowski. Nine years ago following a cut upon the lower left lip by a barber an ulcer appeared at the site of the cut and was treated by surgical removal, by carbon dioxide snow, and by several applications of the actual cautery. At the time patient reported to me there was great pain in the lower left jaw extending up to the left eye and downward to the left clavicle. There was a large mass just to the left of the chin outside the cheek, also one inside firmly adherent to the jaw bone. There was a metastatic nodule in the middle of the lower lip, also many extending downward to the left clavicle. Roentgenograms of the lower left jaw bone showed extensive involvement of the bone in its anterior half. The last incision into the growth had never healed and was a discharging ulcerating fissure.

Treatment was started with the roentgen ray September 5, 1921, at which time the entire neck and face were covered, always centering the rays to the disease. Radium was then planted throughout the mass and metastatic nodules. This treatment, followed by two more series of roentgen rays and treatment was completed November 17, 1921.

Result: There has been no pain since the first roentgen series was completed and the metastatic nodules have disappeared. There is now a firm hard mass of contracting fibrous tissue at site of the primary growth, which has pulled the mouth toward the left. The nodule inside the cheek has disappeared. Roentgenograms of the jaw show that the bone has healed except at one point near the symphysis which gives a typical picture of necrosis. January 3, 1922, the patient was referred to Dr. W. E. Doremus for a plastic operation and care of the necrotic area.

Case No. 2. Mrs. A. B. M. Age 71 years. A patient of Dr. A. B. Twitchell.

Late in July, 1921, a lump appeared at about the middle of the thorax just to the left of the spine. It had been growing rather rapidly just previous to the time the patient was referred to me and the pain was so intense that the patient could not sit while the history was being taken. The growth appeared to be as large as a duck's egg. Roentgen examination by Dr. Charles F. Baker showed, just to the left of the mid-dorsal spine, a growth which had already pushed the spine considerably to the left. Dr. Baker's diagnosis was probable sarcoma arising from the mediastinum.

October 7, 1921, treatment was started. The pain was so great that it was impossible to arrange the patient upon the table and it became necessary to resort to narcosis. Treatment consisted of roentgen rays alone.

Result: One month after treatment patient reported that there had been no pain for two weeks. The external evidence and likewise the roentgen evidence of the growth had disappeared. The spine was straight. This patient was seen one week ago and is still free from pain with no recurrence or metastasis, and she is very happy.

Case No. 3. Mr. H. A. Age 58 years. Patient of Drs. W. E. Doremus and A. A. Mutter.

Present trouble began about two years ago with a somewhat acute attack of absolute constipation which lasted three days. Then followed a year of gradually increasing difficulty at stool. One year after the first attack of absolute constipation another like attack occurred and although the patient eventually secured partial relief the difficulty at stool continued to increase, stools contained blood, and there was general malaise. June 13, 1921, there was another attack of intestinal obstruction which resisted all treatment.

Abdominal section by Dr. W. E. Doremus showed an inoperable mass in the pelvis springing from the sigmoid. A colostomy was done and radiation therapy was advised. Roentgen rays were delivered to the pelvis. The entire pelvis was covered, front, back, and both sides.

One month following the radiation treatment bowels were moving by both colostomy bag and rectum, and upon sigmoidoscopic examination, I found that the instrument passed easily into the sigmoid, whereas in the beginning I had been unable to get the instrument past the rectum. I believed that the case was now operable, which opinion Dr. Doremus confirmed.

At a second abdominal section Dr. Doremus found that the growth was operable. It was removed and the microscope showed it to be adenocarcinoma. Then an end-to-side anastamosis was done and the colostomy closed. This was followed by a series of postoperative roentgen ray treatments.

Result: To date (May 3, 1923) this man is well in every sense of the word. His bowels move daily, without medication, in an entirely normal manner. There is no sign of recurrence or metastasis anywhere. He has regained all the weight lost during his illness and is still steadily putting on additional weight. I am satisfied that Dr. Doremus feels that this result could not have been obtained by any known surgical method of treatment alone. I am equally sure that this result could not have been obtained in so short a time or with so satisfactory results with any known radiotherapeutic method alone. To me this case seems to show distinctly the value of combined methods in the management of malignancy and especially the value of preoperative radiation.

With this case I wish to report eight other cases of inoperable cancer of the rectum and lowermost portions of the sigmoid which I have treated by combined methods of radiation therapy and electrocoagulation. These eight cases are all discharged. All are free from general systemic symptoms of cancer, but at the site of the former disease in each there is, of course, a mass of fibrous tissue, which, due to the normal contraction of scar tissue, has naturally caused varying degrees of deformity of the parts involved, with more or less obstruction. Perhaps some of the cases will require colostomy for obstruction in the future, others may develop metastasis or recurrence; but the fact remains that they are now alive, while I am sure that every one of them would have died long ago, had they been treated by any other method with which I am acquainted. These cases, with one exception, were all started and finished prior to December 31, 1921. Since January 1, 1922, four more cases have been treated by the same method; one died of pneumonia before leaving the hospital, one died an operative death and the other two are too recent for any conclusions to be drawn.

Bibliography.

Boggs, Russell H.: The Local Application of Radium Supplemented by Roentgen Therapy. Surg. Gynec. Obstet. 22:358-365, March, 1916.

Pfahler, George E.: Radium Combined with Electrocoagulation, Surgery and Deep Roentgenotherapy in the Treatment of Malignant Disease. Am. J. of Roentgenol. 6:488-494, October, 1919.

Schmitz, Henry: The Treatment of Cancer of the Uterus. J. A. M. A. 77:608-612, August 20, 1921.

Schmitz, Henry: The Relation of the Science of Physics to Radiation Therapy. Am. J. Roentgenol. 8: 285-291, June, 1921.

Sittenfield, M. J.: New Roentgenotherapy in Cancer. J. A. M. A. 76: 99-101, January 8, 1921.

Stevens, J. Thompson: The Newer Technique for Deep Roentgenotherapy. Med. Rec. 99:834, May 14, 1921.

Stevens, J. Thompson: The Management of Malignancy by Combined Methods. Med. Rec. 98: 815, November 13, 1920.

EDITORIAL

The JOURNAL OF RADIOLOGY

A Journal of Ideas and Ideals.

Published monthly at Omaha, Nebraska, by the Radiological Publishing Company for the Radiological Society of North America.

Subscriptions—In the United States, its possessions and Mexico, $5.00 yearly; Canada, $5.50; elsewhere, $6.50 the year.

Advertising rates on application. All advertising must conform to American Medical Association Rules.

Payments for subscriptions and advertising must be made to Radiological Publishing Co., in New York or Chicago Exchange.

Address all communications to Business Office, 121 South Thirty-third Street, Omaha, Nebraska.

ANNUAL MEETING
Rochester, Minnesota
December 3, 4, 5, 6 and 7, 1923

Professionalism or Commercialism?

"Well, do you believe that anything I have written will survive me?"

These, the last recorded words of Alexandre Dumas, express the sentiment which is deep in every man's heart. The question which really concerns the man, whether he is the artist, the author, the scientist or the physician, is whether his accomplishments will really survive his demise. The great Dumas succeeded in erecting a perpetual monument to himself by his world read novels. More than 80,000,000 copies of his works have been sold in France alone, beside the countless numbers translated into every language. Today the fascination of the Three Musketeers is just as gripping as when fresh from the author's pen. Today Alexandre Dumas remains "the most fascinating writer and the most popular novelist, not only of France, but of the whole world." A great surgeon expressed himself to Alexandre Duma's son in the following glowing tribute to the father: "All our hospital patients recover or die with one of your father's books under their pillow. When we wish to make them forget the terror of an approaching operation, the tediousness of convalescence or the dread of death, we prescribe one of your father's novels and they are able to forget."

Inquiry into the cause of the remarkable success of the life of Alexandre Dumas may prove interesting. His son paid a great tribute when he said: "Man will never take a lasting pleasure in the history of his turpitude and baseness. * * * but he will soon sicken of such pictures and he will always return to what is healthy and cheering. Whenever his mind and heart are appealed to he requires a hope, a consolation, a support and an ideal." Corot said: "Art is not art, unless it makes man merry."

Alexandre Dumas fulfilled all of these requirements, furnishing not only an ideal for all who read, but at the same time giving them great pleasure.

The citation of this valuable and illustrious example in the literary world is not without its value to the medical profession under the present apparent unrest. There seems to be a spiritual unrest among the members of the medical profession, due to the changing economic situation in the United States and elsewhere. There seems to be a struggle to decide between commercialism in its baldest form on the one hand and the pursuit of an ideal on the other hand.

The commercial element in those practising the healing art in the United States is well represented by the money grabbing, advertising methods of the chiropractors and of those who employ the deceitful methods of Abrams. These methods put money in the pocket of the man employing them, but at the same time rob him of an ideal and the patient of a genuine service. Some excuse their methods by saying it is simply good salesmanship. We feel that time will prove that this type of salesmanship in medicine will act like a boomerang just as it has in the business world. The Association of Advertising Clubs has been promoting truth in advertising for a number of years and has induced many newspapers to accept only truthful advertisements. As a result of the adoption of this standard many advertisements of a medical nature are refused space in some of the leading publications. Among those refused are the questionable ones just mentioned.

Professor Gardner of the University of Wisconsin, Department of Commerce, recently advocated a campaign of education carried on by the medical profession as a whole. This material could be prepared by a layman publicist employed by the medical profession, all of his copy being submitted for approval before being published. The purpose of this publicity would be to let laymen know what the ideals and purposes of the medical profession are and to inform them what the profession is able to accomplish in the treatment of the various diseases affecting mankind. Professor Gardner stressed the point that in all this publicity the public would be more apt to read pleasing articles which tell of the hopefulness of serious conditions and the meritorious achievements of the makers of medical history.

A commercial man recently put the problem a little more concretely than did Professor Gardner when he said: "The thing the medical profession as individuals lack is positiveness. The sick man comes to his physician for help and he wants the physician to not only give him the help, but to assure his mind that the course of treatment outlined will give the desired help." It would appear that this man has made a keen analysis of the psychology of the sick individual. The same principles apply here as elsewhere in the realm of salesmanship. This plan, coupled with truthfulness, will solve the economic difficulties of the medical profession.

Unselfish devotion to the ideal of service to humanity will win. Service above self is a practical motto as well as an ideal one. Professor Herman von Schulte, Dean of Creighton Medical College, recently said, "It would appear that truthful service rendered by the physician will naturally bring its financial reward."

A Portion of an Address on Publicity*

The medical profession holds the welfare of society in its hands. It has made almost incredible strides and it is rendering a monumental service, a service which touches us all deeply and personally. The control of typhoid fever, of yellow fever, of tuberculosis, all these are achievements which offer proof of the assertion just made. This truth is well known to each of us here, but the public at large does not realize the truth about medicine any more than it realizes the truth about economics, politics, science or religion.

Following the war, when we saw civilization swept away with a ruthless hand, there came to us a sense of exhaustion and of futility. When I saw men mown down by the hundreds of thousands it affected me so deeply that I

did not care whether I lived or died. It would have been an easy matter for me to have ended the whole thing then, but I came back to sanity and to the realization that in dealing with human nature we are dealing with the stuff that makes anything possible. We know that some people will never amount to anything, but it is impossible to foretell which these ones will be. I do not despair of education, and in my position I know what college men and women are.

Following the war came also the realization of how great is the ignorance of the world and a knowledge of how deeply affected it has been by the old inhibitions, and so today we are experiencing an awakening, manifested everywhere by a seeking after knowledge, a seeking after a new heaven and a new earth in all things, in things as divergent as politics and medical science. The battle waged by Tyndall and by Huxley is not yet won when it is possible for Mr. Bryan to arouse legislators to a point where they are almost ready to prohibit the teaching of biological sciences in our schools. We are threatened today, gentlemen, and as leaders of society we have a responsibility resting upon us. I sincerely believe that it is the duty of the medical profession to bring about, by whatever means possible, a fuller knowledge of the truth.

I think that the premises upon which I base my belief are sound. We will not disagree, I think, that we know more than we used to know, that the new discoveries of psychologists and biologists have yielded results.

I have not made an extensive study of this, but I believe it is true that at the time Huxley delivered his lectures it was quite possible for him to collect a representative audience and to make a speech and have it reproduced, I do not know in just what form, whether in book form, pamphlet form or magazine form, but I do know that he reached a few representative audiences in Great Britain and that though the reading public was smaller than it is today, public opinion could be formed and leadership created by use of the lecture, and perhaps pamphlets, more easily than is possible today, when everybody reads the newspapers at least.

To illustrate what I mean let me say that at our university we have found Freshmen who literally and absolutely have never read any book outside of the books read in school. Their families owned no books, they had never bought a book, never borrowed a book, had never read even a novel. It may seem incredible. I do not think it is a widespread situation, but such people do exist. They do not read books, but they read magazines and newspapers.

This lends force to the statement that if you reach the public of today you must make use of the media which the public uses. The utterances of only our most prominent men, such as Hoover, Harding, Wilson, are reproduced in the newspapers because the newspapers know that the public does not care for much of this type of reading. Editors are blase and cynical, they think that they know what the public wants and they give it to them. Great orators and publicists know how to appeal to and to form public opinion, but the professional man rarely knows how to appeal to the public, it is an art by itself. A doctor says to a newspaper man, "Publish this," but usually it looks pretty dry to the newspaper man, he thinks the public will not read it and he says so.

I have no easy formula to present, but I do believe that if Huxley and Tyndall were here again that they would use whatever implement they found at hand to make the truth prevail. I think my reaction when it comes to doctors advertising is about the same as is yours. I have a feeling not based solely upon traditional ethics, but upon another feeling, and I would say do not advertise in this way. I could not stultify myself and my friends by advertising in the blatant, vulgar, disgusting way of the chiroprators, and whatever publicity medical men undertake should not welter in gore. The layman is not a scientist and he cannot look unmoved upon pictures of cancer, etc. I have in mind a medical journal that wanted to advertise medical truths and started off with pictures of cretins and other horrors. Lately I heard a lecture by the great rebuilder of war-wrecked faces, and I saw the slides illustrating this lecture, and although I was glad to learn these things, it made the entrails curl up inside of me. The layman will only turn and run in the other direction when presented with this sort of thing. In contact with your patients you take infinite pains not to offend their sensibilities, not to terrify them, but to guide them safely through the vale of terrors in which they find themselves, they lean on your arm and you shield them from these terrors and from that worst terror, the imagination. The public mind will have to be considered if you want to undertake publicity.

You are scientists, you are assailed by quacks, the public is assailed by quacks. How they may affect your pocketbook does not concern me, but my welfare and that of my wife and boy does concern me, and I do not want them treated by a quack while you sit silently by, unable to utter a word. You need not advertise like a chiropractor, like the manufacturer of shredded what, or of soap or of face cream. Your advertising must be dignified and unique. It is a thing that can be done, it is simply an application of brains to the problem. I wish that I knew how to make what I have to say more forceful. I believe in education and in the responsibility of the educated mind to lead public opinion. An article in the Saturday Evening Post scores the average citizen because he does not take a part in politics, but lets others lead. What shall be said of the medical man if he hides his light under a bushel?

If you are imbued with the truth and want to make it prevail, then in Heaven's name seek out a way. I believe if the best brains were given the problem they would find the way, because of the magnitude of it.. It is a marvelous thing, a thing that cannot be surpassed in advertising, it never could be, for there is nothing which surpasses in greatness the struggles that medical men have so willingly gone through with for the sake of humanity. It can be done. It's up to you.

*—Presented before the Omaha-Douglas County Medical Society at the University Club, May 1, 1923, by Prof. Edward Gardner, Department of Commerce, University of Wisconsin.

Recognition Abroad

Dr. Arial W. George, of Boston, was honored by being chosen to deliver the annual Sir James MacKenzie Davidson Lecture, which he did at London, May 17th, before a joint meeting of the Roentgen Society of London and the Electrotherapeutic Section of the Royal Society of Medicine. "The Pathological Gall-Bladder" was the subject of his lecture.

Dr. George is the first American to receive the Sir James MacKenzie Davidson Medal, a tribute of which he and his countrymen may well be proud.

South Dakota Radiological and Physiotherapy Society

At a meeting held May 21st, 1923, at Watertown, S. D., the South Dakota Radiological and Physiotherapy Society was organized with the following officers:

President.....N. J. Nessa, M.D., Sioux Falls
Vice-President.....F. Koren, M.D., Watertown
Secretary-Treasurer.....W. D. Alway, M.D., Aberdeen

Nebraska State Radiological Society

The following officers were elected at the meeting of this society, held at Lincoln, May 14th, 1923:

President . . . . . R. L. Smith, M.D., Lincoln
Vice-President . . . . R. C. Woodruff, M.D., Grand Island
Secretary-Treasurer . . . . . R. W. Fouts, M.D., Omaha

Western Electrotherapeutic Association

The fifth annual meeting of this association was held, under the presidency of Dr. T. Howard Plank, at the Little Theatre, Kansas City, Missouri, April 19 and 20, 1923.

Preceding the meeting the Western School of Electrotherapy, held a three days' session, with a class of one hundred.

The following officers were elected for the coming year:

President . . . . . H. H. Bowing, M.D., Rochester, Minn.
First Vice-Pres. . . E. H. Skinner, M. D., Kansas City, Mo.
Second V.-Pres., A, David Wilmoth, M.D., Louisville, Ky.
Treasurer . . . . . W. P. Grimes, M.D., Kansas City, Mo.
Registrar . . . . . B. C. Harris, M.D., Sapulpa, Okla.
Board of Trustees . . T. Howard Plank, M.D., Chicago, Ill.
. . . . . B. B. Grover, M.D., Colorado Springs, Colo.
Secretary . . . . . Charles Wood Fassett, M.D., Kansas City

Next meeting will be held in Kansas City, April, 1924.

CHARLES WOOD FASSETT, M.D., *Secretary.*

DEPARTMENT of TECHNIQUE

Practical Problems in the Administration of High Voltage X-Ray

ROBERT H. MILLWEE, M. D.
Dallas, Texas

AT THE Chicago meeting a year ago it was my pleasure to talk to you briefly regarding a new type of x-ray installation in which the tube was enclosed in a booth. I am well aware of the fact that physicians and research workers have for many years employed the method of passing bundles of x-rays through a hole in the wall for experimental work, and possibly some one has used the method in treating patients before the idea originated with the writer.

The primary reason for developing this type of installation was the fear of the patients coming in contact with high tension wires, and it was only after its installation that many other good features were discovered. It will be remembered that this type of installation utilized a perpendicular wall and that a horizontal beam of x-ray passed through the opening in the wall in order to reach the patient. Many modifications of this installation have since been employed by Soiland, Ernst and various other workers.

While treating patients with this type of installation over a period of almost two years we naturally recognize its defects, as well as its many good features, and an effort has been made to eliminate, so far as possible, the imperfections. One of the more important features added is that of treating two patients from the same tube at the same time.

A careful study of the report of Dr. Coolidge on the distribution of radiation from the target of a Coolidge tube, as published in the American Journal of Roentgenology, and a study of Fig-

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, December 5th, 1922.

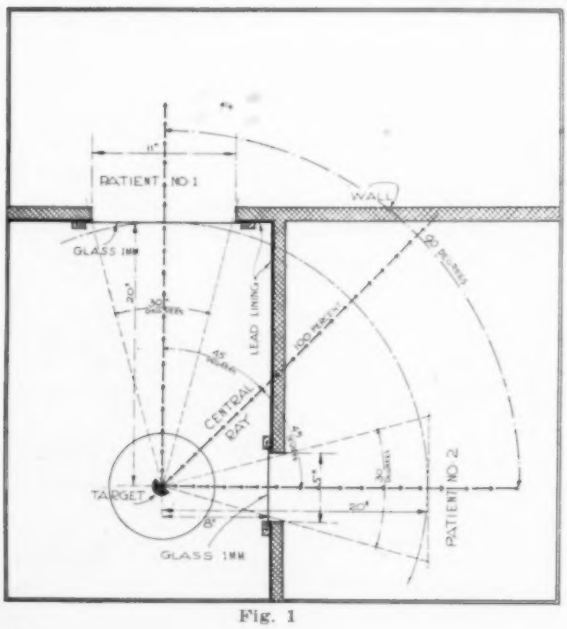


Fig. 1

Fig. 2

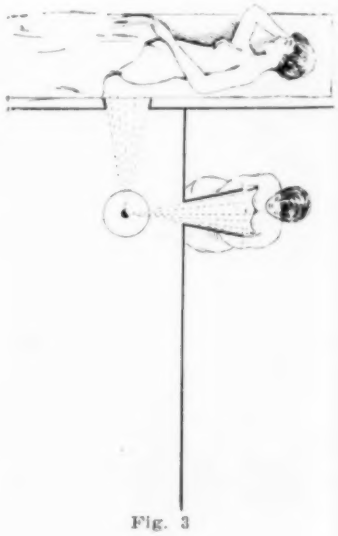


Fig. 3

ures 1, 2 and 3 will convince one that the procedure is scientific.

The writer's own installation, as used at the present time, does not have the entire transformer room lead lined, but the tube is contained in a closet 3½ by 2½ feet wide and 6 feet tall and the high tension terminals pass into this closet through insulators. The closet is lined with three-eighths inch sheet lead and a current of air is forced through it for cooling and ventilation. This is done by means of a blower situated at the floor, which takes the air by means of a pipe from the top of the transformer room in order to remove gasage from this room, and blows it directly onto the tube and passes out at the top of the booth by means of a second conduit, changing the air completely in both the tube booth and transformer room once each minute.

It will be noticed in Figure 1 that the tube is placed near one wall and quite a distance from the other wall. From wall No. 1 it is placed at a distance of 20 inches; that is, the position is such that a 20 inch skin target distance is possible if the patient is placed against the wall. This makes a desirable arrangement for treating a patient in the prone position, while at the other portal of entry it will be noticed that the tube is placed with the glass within four inches of the wall so that it is possible to secure an eight inch skin target distance, and by using a cone a twenty or twenty-five inch skin target distance is easily secured with the patient facing the tube in a sitting position, and yet the patient will have sufficient room for the knees to be comfortably situated. From this hole a patient may also be treated in the prone position. Where the glass of the tube comes within four inches of the wall we find it necessary to use glass for installation, hence 1 mm. of ordinary window glass is used over both holes, which offers about the same resistance as 1 mm. of aluminum. Clear celluloid 1 mm. in thickness is hermetically sealed over both holes in order to prevent the escape of gases and noises from the booth.

A careful study of the position of the tube in the booth as illustrated by Figure No. 1 probably conveys the idea of the arrangement more clearly than can be given in a word picture. It will be noted that the central ray is directed half way between the two portals of entry, or holes in the wall, and that the central ray passing through each hole comes from the target of the tube at an angle of 45 degrees from the central ray of the target, therefore the central rays from each portal of entry are 90 degrees from each other. It will also be noted that the ray through each portal of entry is utilized an additional 15 degrees away from the central beam of ray, so that in treating each patient, in case we should use a very large portal of entry, 11 inches in diameter, we would use a bundle of rays extending from about 20 degrees from the central ray to about 65 degrees. However, since we usually employ portals of entry of about one-half this size it is not often that we find it necessary to use this ray to a greater degree than about 52.5 degrees from the central beam.

We have made a rather careful study of the distribution of rays from the targets of six tubes and from this investigation I am convinced that the intensity of the radiation 65 degrees from the central ray of the average Coolidge tube is not materially less than that at 20 degrees from the central ray or at the central ray itself. The one factor which seems to alter the distribution of the ray from the surface of the target as reported by Dr. Coolidge, and it can readily be understood by all of us, is the character of the pitting of the target, and we can readily understand how the target may be so deeply pitted that there may be an appreciable variation in the amount of radiation over the area illustrated by Figure 1, and since the appearance of the target will not give us a very definite idea as to the alteration of this distribution of ray it is at once apparent that the mere me-

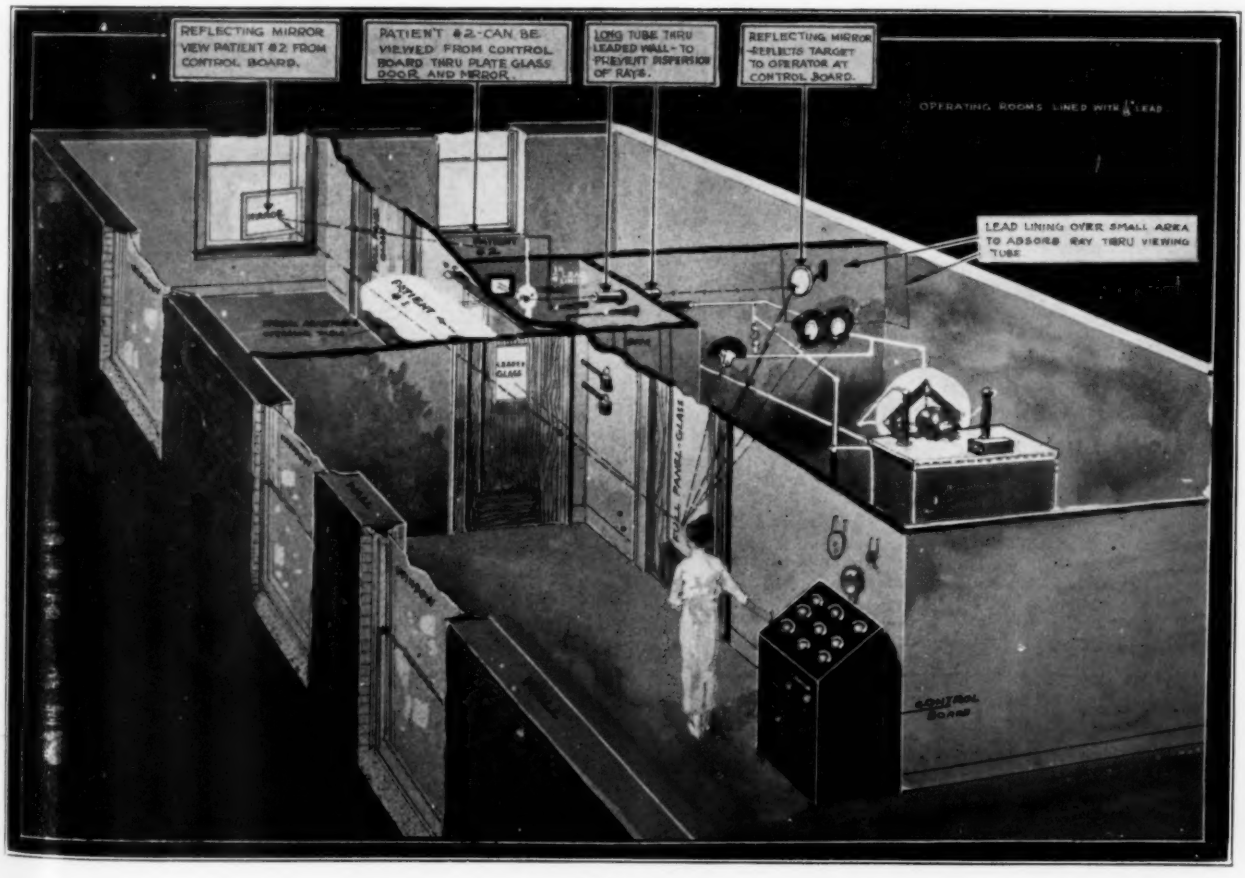

REFLECTING MIRROR VIEW PATIENT #2 FROM CONTROL BOARD.
PATIENT #2-CAN BE VIEWED FROM CONTROL BOARD THRU PLATE GLASS DOOR AND MIRROR.
LONG TUBE THRU LEADED WALL-TO PREVENT DISPERSION OF RAYS.
REFLECTING MIRROR-REFLECTS TARGET TO OPERATOR AT CONTROL BOARD.
OPERATING ROOMS LINED WITH 1/8" LEAD
LEAD LINING OVER SMALL AREA TO ABSORB RAY THRU VIEWING TUBE
PLATE GLASS
CONTROL BOARD

Fig. 4

chanical setting of the target for securing the radiation of two patients at one time is not a scientific process, and therefore the setting of the position of the tube must be accomplished by the aid of some method of measuring the radiation.

The author has employed the ionization process by the use of electroscopes and also the galvanometer as described by Duane, and I believe the Duane process to be most suitable for the use of roentgenologists.

A method may be adopted to treat two patients from one tube, utilizing a leaning wall. In this there is the suggestion to the patient of being under something which may fall, and it does not permit of such perfect ventilation of the treatment room nor is it so convenient for making measurements of radiation as the perpendicular wall, particularly if water phantoms are used.

Figure 4 illustrates the author's own installation and is shown particularly to indicate those important things which the operator is able to observe from one position. It may be well to call attention to the following: That from one position the operator is able to observe patient No. 1 by direct view through leaded glass in door; that she observes patient No. 2 in a mirror which reflects the image of patient No. 2 through the panel of glass in partition between the two treatment rooms; that she observes sphere gap, milliamperemeters and voltmeters, and that she observes the target of the tube by reflection and that this image of the tube passes through a long piece of pipe through the booth wall in order to prevent dispersion and scattered radiation; that both the operating and the two treatment rooms have outside windows which give sufficient light and ventilation, adding materially to the comfort and well being of patients and operator.

Fig. 5

Fig. 6

Since in using this method we shift the patient rather than the tube, we have attempted to solve the problem of shifting the patient in room No. 1 by the aid of a table in the construction of which is used a double lift dental base, or rather the base used in dental chairs, which allows the tube to come within 18 inches of the floor and has an 18 inch lift. This table is illustrated in Figures 4 and 5. The patient may be placed on the table at a height of 18 inches and then, with a long easy foot pump, raised to the proper level for treatment. Allowing the patient to be placed on the table in a low position does away with the suggestion of climbing upon something high, from which one may fall. In the case of patient No. 2 a chair resembling the ordinary dental chair is employed, which also has an 18 inch lift and a head rest. This chair and its uses are illustrated by Figures 4 and 6. Cones of various sizes and lengths are employed and the chair and table being situated on ball bearing castors are very easily manipulated, and we find it as easy to shift the patient by this arrangement as it is to shift the tube in our former method of treatment. We also find that patients generally prefer to take their treatments in a sitting position and this can usually be more easily accomplished, with a few exceptions such as pelvic conditions.

It is probably unnecessary to call attention to the great saving of time to both physician and operator, as well as the saving of wear and tear on apparatus when we treat two patients by the same facility as we formerly treated one patient.

CASE REPORTS

An Unusually Interesting Case

T. HOWARD PLANK, M. D.
Chicago

THE LITERATURE upon the subject of bone metastasis from carcinoma of the female breast is rather infrequent, and, therefore, I am presenting this report of a case which was under my constant care for nearly eight months.

The case was referred to me on January 12, 1922. For three months the patient had had considerable pain and discomfort in the right hip. Operation was delayed until after x-ray examination which showed lipping of the right transverse process of the third lumbar vertebra (Fig. 1), involvement of the ilium about the right sacro-iliac joint, also involvement of the right trochanter and upper third of the right femur as illustrated by the picture.

Physical examination at this time disclosed a hard mass involving the upper, outer quadrant of the right breast, extending into the upper inner quadrant and adherent to the integument and pectoral muscles. The axilla was filled with a similar mass of about the same size and attached to the blood vessels. There were a number of nodules in the supraclavicular space. The case was considered an inoperable one because of the extensive local metastasis and the fact that the patient had been aware of the mass for over two years.

In the following pictures you will note that the body of the vertebra has almost completely disappeared, while the disks are neary intact (Fig. 2). This is quite characteristic of malignancies in this region and is in contrast with tuberculosis of the spine, in which instance the disks as well as the body are destroyed.

With this additional data I considered the case incurable and treated it as such.

Figure 3, taken a month later, February 22nd, 1922, shows the right half of the third lumbar broken down, but with some improvement in the condition of the ilium at the sacro-iliac joint. Figure 4, taken at this time shows a pathological fracture of the right trochanter.

Fig. 1—Beginning destruction of the third lumbar.

Fig. 2—Total destruction of tenth dorsal, except disk. Showing destruction of upper and lower dorsals and lumbars.

March 22, 1922, the roentgenogram showed improvement of the third lumbar vertebra, also the beginning destruction of the tenth dorsal, left side. April 4th, 1922, roentgenograms showed improvement in the condition of the sacro-iliac joint and extension into the right trochanter.

On May 2, 1922, the picture showed the third lumbar vertebra remaining stationary, but showed a complete destruction of the tenth dorsal vertebra. On May 31st the picture (Fig. 5) showed the beginning destruction of the fourth cervical and second dorsal vertebrae with complete breaking down of the tenth dorsal vertebra.

July 6, 1922, the destruction of the third and fourth cervical vertebrae was almost complete (Fig. 6). August 4, 1922, the x-rays showed destruction of the fifth cervical and third and fourth dorsals, also renewed destruction of the third lumbar and beginning destruction of the first and fifth lumbar vertebrae. About the middle of August there was a complete breaking down of the third and twelfth dorsals.

The last picture, taken a few days before the patient died, on August 22, 1922, showed a complete breaking down of the third lumbar and further involvement of the fifth lumbar with complete involvement of the ilium, ischium and pubes. There was renewed involvement of the upper third of the

Fig. 3—Further destruction of the lumbar and illii.

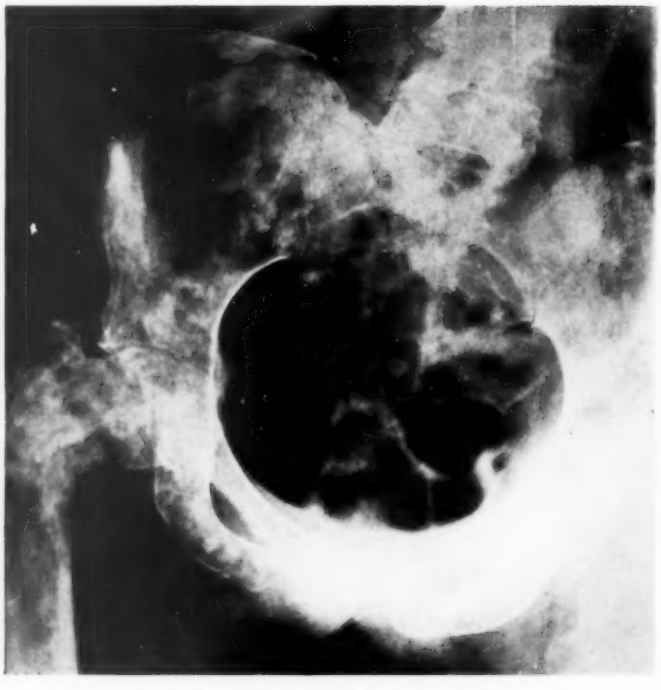


Fig. 4—Destruction of both illii and right femur, upper third.

right femur and the involvement of the upper fourth of the left femur.

During this time there was no paralysis and not enough pain to require morphine.

The amount of radium used during the eight months this case was under treatment totaled 25,000 milligram hours.

The last blood count, taken ten days before death, showed:

Hemoglobin	71%
Erythrocytes	2,870,000
Leukocytes	15,800
Neutrophiles	93%
Small lymphocytes	0
Large lymphocytes	1%
Basophiles	1%

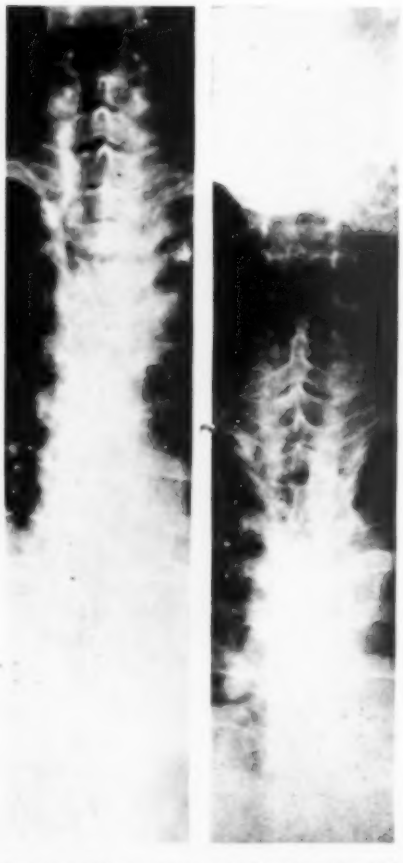


Fig. 5—Destruction of the fourth and fifth cervical, and beginning destruction of the third and fourth dorsals.
Fig. 6—Further destruction of the cervicals and dorsals.

Obstructing Foreign Body in the Esophagus Unknown to Patient

E. L. JENKINSON, M. D.
Chicago

PATIENT, a white male, 41 years of age, entered the hospital complaining of pain in the mid-sternal region, with great difficulty in swallowing. The difficulty in swallowing was not constant, as there were times when he experienced practically no feeling of fullness in the mid-sternal region and the food seemed to enter the stomach normally. During the periods of dysphagia the food was regurgitated and not even water would pass the apparent mid-sternal obstruction.

The pain was present at all times independent of food taking, and was dragging in character, accompanied by a heartburn. The emptying of the esophagus did not, to any degree, lessen the discomfort. The patient had been in excellent health up to February 25, 1923, never having experienced any difficulty in swallowing.

On February 25th, at the evening meal, the patient found it impossible to take anything by mouth. The sight of food seemed to cause him to vomit. The vomitus, however, contained none of the food eaten at the preceding meal. After several attempts to take water and coffee without success, the patient decided it was useless and attributed it to a cold which had settled in his stomach. This difficulty in swallowing continued for two weeks, during which time there were periods when the food entered the stomach with no delay. The patient seemed to anticipate times when he could swallow, and at these times would take nourishment. The dyspagia seemed to be worse in the mornings than at any other time during the day.

On March 10, 1923, the patient attempted to eat some semi-solid food. The meal consisted of potatoes and hamburger steak, which was cut into very small pieces. The first mouthful was all that was attempted, as the pain was very severe, and he thought he would strangle. The following day he came to the hospital, and was admitted under the diagnosis "Stricture of the Esophagus."

The past history is as follows:

The patient had had the ordinary diseases of childhood, measles, mumps, chicken-pox and scarlet fever. Twelve years ago he had had a primary lesion for which he had taken considerable treatment and which had been pronounced cured by his physician. Since the treatment he has enjoyed very good health.

During the winter months the patients hands break out, and a scaly, weeping eruption results, which lasts through the cold weather. During the present winter, however, he has had no eruption on his hands.

Nothing in the past history other than that mentioned above, was of any importance.

Habits

The patient uses alcohol, tobacco, tea and coffee in moderation. The appetite has always been good. Sleeps well and does not use drugs.

Family History

Father living and well at the age of 65. Mother living and well at the age of 60. The patient has six brothers and one sister all living and well. The oldest is 43 and the youngest 27.

There is no history of tuberculosis, carcinoma, nephritis, diabetes or nervous disorders in the family.

General and Negative

The patient gives no history of headaches, dizziness or faintness. The eyes, ears, nose and throat and mouth are negative for pathology. The two upper central incisors are absent.

There is no history of any pathology referable to the heart and lungs or the genito-urinary tract.

The urine while in the hospital showed a faint trace of albumen, and a few leukocytes, epithelial cells and red cells. On March 13th, there was a slow reduction to sugar with ten drops of urine. The reduction, however, was not present on further examination.

The blood count was as follows: Reds, 4,300,000; Whites, 10,500; Hemoglobin, 94. The Wassermann was clearly negative with acetone insoluble and cholestrinized antigens.

On Saturday, March 11th, the patient was brought to the x-ray department for fluoroscopic examination of the esophagus. The usual fluoroscopic examination of the heart, lungs and mediastinum was done before allowing the patient to swallow the barium suspension. The examination was done with special reference to the posterior mediastinum. In the middle third of the mediasinum there was a very indefinite circular area of density. The shadow was about the size of a dollar, and was thought to be due to some inflammatory reaction, such as a mediastinitis.

The barium suspension in buttermilk was then given. In the middle third of the esophagus there was a definite filling defect with a slight delay in the passing of the suspension. The lumen of the esophagus was irregular; the irregularity involved about two inches of the esophagus. During the fluoroscopic examination, numerous films were made in different positions. The films were later carefully examined. The filling defect was very apparent, and a tentative diagnosis of cancer of the esophagus was made. The following day the films were again studied; we felt that in view of the fact that a primary lesion had been admitted, the possibilities of lues as the cause of the stricture must be considered. In one of the films there was a peculiar regular convexity with a concavity below, and through the barium shadow, a rather dense shadow could be located in several of the films, but nothing could be differentiated. The constant appearance of this indefinite something and the regular concavity and convexity in the esophagus made further investigation necessary.

The patient was again brought to the roentgen department and radiograms were made in the standing position in the left and right oblique position, using a fine focus tube. Stereoscopic films were also made of the chest. During the second examination the patient was again thoroughly questioned with special reference to having swallowed any foreign body, bone or teeth. To all of the above questions he answered in the negative. The films, however, solved the problem and made an accurate diagnosis possible. In the middle third of the esophagus was a partial dental plate containing two teeth.

Figures 1 and 2 show the x-ray films with the plate and teeth clearly outlined. Figures 3 and 4 show the teeth after removal, with a special scale denoting the width of the plate. Figure 5 is the x-ray film demonstrating the filling defect in the esophagus.

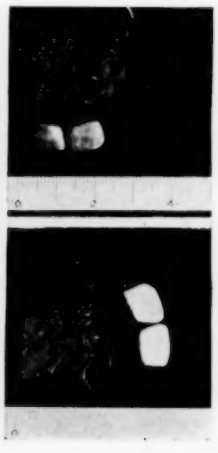
After the discovery of the teeth, the patient was told the cause of his difficulty in swallowing and again questioned. He was greatly surprised, but had no recollection of having swallowed them. The possibility of the patient having been under the influence of alcohol was definitely ruled out, as he had not taken a drink for two months previous to the initial symptom. He recalled very vividly having had the plate on February 24th. The following explanation was given by the patient: He felt sure the teeth were swallowed in his sleep. When he missed the teeth, on February 25th, he went back to his room, thinking he had left them on the dresser in a towel. Being unable to find them, he felt the maid had thrown them out with the soiled linen. The maid was questioned, but had no recollection of it, as the soiled linens were thrown into a hamper and sent to the laundry.

On March 13th, Dr. John Cavanaugh was called in to examine the patient and to decide on the method of removal of the foreign body. An esophagoscopy, without anaesthesia, was performed. The patient cooperated very satisfactorily, and after the use of the extension, the foreign body was very readily located. The plate was quite adherent and very careful manipulation was necessary for fear of penetrating the wall of the esophagus. The plate having been in the esophagus for about three weeks, the possibility of necrosis was not to be overlooked. When the forceps were applied to the foreign body, it was necessary to slightly turn it before removal was possible. After the turning, the plate was removed without difficulty.

The patient was then put to bed and nothing was given by mouth for three days, during this time glucose and saline

Fig. 1

Fig 2



Figs. 3 and 4

Fig. 5

were given per rectum. Morphine was used during the first two nights to relieve the pain and to keep the patient quiet. Four hours after the removal of the plate the temperature rose to 101.6. The pulse also increased to 100. The following day the temperature dropped to normal, and the recovery was uneventful.

On the fourth day the patient was allowed fluids by mouth, consisting of milk, eggnog and coffee. The sixth day soft boiled eggs and cereals were included, and on the tenth day a soft diet was allowed. The day of the discharge, March 22d, a thorough fluoroscopic and radiographic examination was made with special reference to the esophagus and mediastinum. The lumen of the esophagus was quite normal, showing no evidence of a stricture, there was no evidence of any mediastinal involvement.

Conclusions

1. The above report seems to be definite proof that a patient may swallow a large foreign body without knowledge of the occurrence.

2. A careful history may in some cases be misleading. All means at our disposal must be brought to use before deciding upon a definite diagnosis.

3. A careful radiographic examination is of utmost importance in the examination of esophageal conditions and far surpasses fluoroscopy. Every case complaining of difficulty in swallowing should be radiographed in the standing position in both the right and left oblique before the barium meal is given. I feel sure there are a certain number of patients who complain of dysphagia which may be due to some foreign body swallowed years before which they either knew nothing about or have forgotten. The resultant irritation may have caused a scar which is the cause of their present trouble. There is the possibility of malignant changes taking place in the scar.

4. Poorly fitting dental plates should not be used; a plate that has a corner chipped off should be repaired immediately, as the suction is reduced and the plate will not stay in place swallowing may result. Every dental plate, partial or complete, should be removed from the mouth before retiring.

ABSTRACTS and REVIEWS

X-Rays. By G. W. C. Kaye, O.B.E., M.A., D.Sc., F.Inst.P., Superintendent of the Physics Department of the National Physical Laboratory, Past President of the Roentgen Ray Society, Editor of the Journal of the Roentgen Society, Honorable Member of the Society of Radiographers. Fourth edition. Octavo, 320 pp. 126 illus., 1923. Cloth, $5.00 net. Longmans, Green & Co., 4th Ave. and 30th St., New York City; 39 Paternoster Row, London; Bombay, Calcutta, Madras.

THIS BOOK, appearing in its fourth edition, needs no introduction to the radiologist. The author has kept to the same purpose held in previous editions, namely, to give "an account of such of the present day methods and apparatus as appear valuable or novel, and which in many cases can only be found scattered throughout many journals; it deals with the physics of a number of the main principles of radiology, being concerned with the development of theory as well as of experiment; it attempts to convey a notion of the historical trend of events from Professor Roentgen's world famous discovery in 1895 down to the present year." This edition has been extensively revised and some of it has been entirely rewritten. More space has been given to x-ray spectrometry and there is a new chapter upon x-rays and x-ray materials. The author has drawn from many of his recent lectures in his discussion of the application of x-rays. The tables of physical and chemical constants and of some mathematical functions were written by the author and T. H. Laby, M.A.

The work is, to quote the author, "neither recondite nor mathematical." The subject matter is very compactly written, but with the logically presented and easily understood explanations of the phenomena of x-rays the book is fascinating to the intelligent layman as well as to the radiologist. To the latter it is an almost indispensable treatise, containing as it does information which otherwise he would search far and wide to obtain.

The main part consists of 15 chapters with the following headings: Phenomena of a Discharge Tube; Cathode Rays; Positive Rays; X-rays (Discovery and Production); An X-ray Bulb; High Potential Generators; The "Hardness" of a Gas X-ray Bulb; The Blackening of an X-ray Bulb; The Measurement of X-rays; Scattered, Characteristic and Secondary Corpuscular Rays; Further Properties of the X-rays; Practical Applications of X-rays; X-ray Equipment and Technique; Diffraction of X-rays by Crystals; The Nature of the X-rays.

An appendix divided into five chapters gives Sir James Mackenzie Davidson's account of an interview with Professor Roentgen. Following this chapter the author discusses the production of high vacua, electrical insulators, protection of x-ray operators, x-ray and electro-medical terms with notations upon the very newest ones. There is also a chapter giving tables of atomic numbers and weight, densities, values of e/m, cathode ray velocity and potential, wave length and potential, and a table of characteristic rays.

The index is ample, covering almost one thousand topics.

Too Lazy. Abstracted from an Editorial in Southwestern Medicine, 7:135, April, 1923.

THE WRITER of this editorial first quotes Dr. Colcord as follows: "If I were to name the one chief cause of surgical failure, in almost every case it would be laziness. Too lazy to take pains, too lazy to read books and journals, too lazy to visit hospitals and clinics, to attend medical meetings, to learn the newest and best methods. I have said long ago that a lazy man had no business to be a surgeon."

The editor goes on to say that this incident of surgical failure could be applied to every line of medical effort. Many, he says, have grown fat and complacent, thinking their knowledge superior to that of their confreres, and have ceased to read or to attend medical meetings, and he cites the case of a supposedly well informed doctor asking with great surprise regarding a certain method of treatment which had been discussed in medical journals for two years past. The license of any such man, the writer says, should be revoked, as he is not sufficiently well informed to be permitted the responsibility of dealing in human life.

A Clinical and Roentgen Ray Study of Tuberculous Bronchoadenopathy. Thompson Frazer, M. D. and John D. MacRae, M. D. J. A. M. 80:1292, May 5, 1923.

THE data relating to the diagnosis of this lesion in childhood comprise: *a history of exposure* (not of much importance); the *Pirquet skin test* (negative reaction of value in excluding infection, but the positive reaction not necessarily indicative of infection); *symptoms*, of which loss of weight and easy fatigability are the most important in children; *physical signs* (value of these is questionable because as yet the norm for signs in the child's chest is not established); the *roentgen ray findings*, (should not be relied upon to the exclusion of other signs).

The authors submit the following impressions gained in an attempt to determine roentgenologically what is the norm in the child's chest (it must be remembered that what is normal at birth is quite different from what is normal for a healthy child at puberty):

"The chest should be symmetrical, the trachea in the midline, bifurcating in front of the body of the fourth dorsal vertebra or a little lower. The domes of the diaphragm are smooth; the right diaphragm is in front of the eighth interspace, and the left slightly lower. The mediastinal shadow shows the heart to be more nearly transverse than in the adult, and in the very young the thymus shadow is sometimes recognized about the aortic arch when no symptoms of enlarged thymus exist. The hilum, or root, shadow is located in the inner zone, and extends upward to about the fifth rib posteriorly, and downward till it crosses four ribs and intervening rib spaces; its width and density vary very widely in health. The lung fields show no markings in the outer zone, and, in the very young, none in the middle zone.

"At birth, lung markings, i. e., trunk shadows, are absent and the hilum shadow is small.

"As the child gets older, dust inhalations and infections make for more distinct shadows. The hilum shadow is produced by lymph nodes, thick-walled bronchial tubes, blood-filled vessels, and connective tissue binding them together, and it is to be noted that these shadows increase in density and area, whether a history of infections is obtainable or not.

"Lymphadenopathy becomes apparent after the common diseases of childhood, especially those which involve the respiratory tract, such as whooping cough and measles, but it must be remembered that the lymphoid tissues in children are peculiarly prone to react to other infections, notably chronic appendicitis, and diseased teeth and tonsils. At this point let us urge against the tendency to read tuberculosis into films showing large hilum shadows unless these other causes can be excluded.

"There is a group presenting as its salient feature marked hypertrophy of the tracheobronchial lymph nodes, and another group in which the same hypertrophy is associated with calcification of the nodes. All of the first group gave a positive Pirquet reaction and had known tuberculous foci elsewhere in the body. Those with calcified nodes occurred in cases in which tuberculous bone lesions were present, with the exception of one case of osteomyelitis which gave a negative Pirquet reaction. If the roentgenogram had been relied upon exclusively, some faulty deductions might have been made, for all of these children were in good health so far as their chests were concerned.

"We have been struck with the fact that all cases in which bone lesions existed showed marked calcification of hilar lymph nodes, and we submit the question: Does calcification of these nodes necessarily indicate the presence of a tuberculous process?"

Errors in Interpretation of Lesions of the Sinuses. F. M. Law, M. D., Am. J. Roentgenol. 10:301-303, April, 1923.

THERE are disease conditions of the sinuses which often are indicated by other criteria than that of opacity to a greater or less degree. Too often this is the only thing considered by the radiologist in interpreting the plate. Such conditions are most often existent in cases where the symptoms are indefinite and the pathology vague.

There is very frequently a lack of agreement between surgical findings and previous x-ray diagnosis. Some of the reasons for these disagreements the author has discovered and has set forth as follows:

(1) Oftentimes the explanation of disagreement lies in the fact that shortly before the x-ray picture was taken the patient has cleared the nasal passages, completely draining the ethmoids and antra for the time being. The result is a clear plate, followed by a surgical finding of pus if operation is done. Such an examination is not without value, however, for if surgery reveals pus under these circumstances it is clear proof that granulations do not exist; granulations may not be differentiated from pus, as both conditions render the plate opaque, but a clear plate plus a surgical finding of pus indicates that granulations do not exist. Conversely, an x-ray finding of an opaque antrum plus the failure to find pus upon surgical examination indicates granulations. In doubtful cases two examinations should be made.

(2) Another source of disagreement is that fairly frequently there is entire absence of any antrum, giving of course an opaque plate. It is therefore wise to make a plate in an oblique position. Another anomaly, not so frequently encountered, is the presence of a double antrum. In such a case the posterior half may be clear and the anterior half opaque. If the perforation is of the posterior portion the x-ray diagnosis will seemingly be wrong. The same thing may occur in the frontal sinus as well. If such an anomaly does exist careful examination in the lateral position will reveal it.

(3) Again, it is too often the case that the roentgenologist pays too little attention, or none at all, to the outline of the bony structures. The secret of an indefinite pathology will often be revealed right here instead of by some gross lesion. For instance, if the ethmoid capsule is situated far forward and consists of large cells, then an inflammatory condition of the ethmoids may close the infundibulum leading into the frontal sinus. Chronic inflammatory changes cause symptoms difficult for the surgeon to account for but they may often be accounted for by careful study of the quality of bone entering into the septa. If the ethmoidal septa are thinned out, absorbed or thickened it is very often due to a chronic condition that the patient has noticed only recently and has reported as of short duration.

There is always a reason for any difference between the surgical and the radiographic findings, and though this may be difficult to discover, patient, intelligent search will usually reveal it. The gross manifestations, as has been said, should not entirely occupy the attention.

X-Ray Examination of the Chest. Bernard Hudson, M. D. and Percy G. Sutton, M. S. R., The Lancet, 204: 535, March 17, 1923.

THIS paper is based upon the author's experience in the English Sanatorium at Montana, Switzerland.

The normal chest under the fluoroscope will show two upright clear areas which light up more clearly upon inspiration. They are divided by the mediastinal shadow. On each side of this and at the root the hila are seen with their branch-like markings, which may vary considerably. Two dome-like shadows mark the diaphragm at the base, the right one being slightly the higher. These shadows rise and fall with respiration. Normal lung tissue often shows a faint mottling impossible to distinguish from pathological mottling unless one has had experience in this differentiation.

The authors take issue with the view, so widely held, that pulmonary tuberculosis which cannot be discovered by clinical methods cannot be discovered by roentgen ray examination. They have had cases under their care where physical signs were entirely absent in

the chest but where symptoms pointed to tuberculosis, and this was confirmed upon x-ray examination by the finding of glands and masses of infiltration around the hila. Even in cases well established by clinical diagnosis the x-ray will give a much more complete and comprehensive idea of the case than can be formed without it.

The fluoroscope as well as the plate should be employed, as one will often show what the other does not. "By radioscopy can be observed the degree of expansion of the lung, the displacement (if any) of the heart, the range of movement of the diaphragm on each side, and whether that movement is free, hampered or absent, the presence of pleural adhesions, costal or diaphragmatic, and the presence or absence of fluid * * * a very recent tuberculous lesion throws very little if any shadow on the x-ray plate, and the shadow thrown deepens with the age of the lesion and with the amount of fibrotic transformation it has undergone * * *.

"One of the principal uses of the x-rays in pulmonary tuberculosis is when deciding as to whether or not a case is likely to benefit by artificial pneumothorax. Information is gained as to the site where puncture would probably be most succesful, and as to the presence or absence of adhesions. A radiogram is also in our opinion absolutely necessary in order to determine whether or not the other lung is free from disease or at any rate in such good condition that artificial pneumothorax may be reasonably attempted on the diseased side. In the after control of pneumothorax cases radioscopy is of the greatest value; one is enabled by this means to estimate the shape and size of the cavity, whether adhesions are present, the degree of collapse of the lung, and the presence or absence of fluid.

The upright position is the best for fluoroscopy as it permits easy manipulation and more rapid centering of the tube. A costly upright screen is not necessary—the authors use a simple wooden screen of home manufacture.

For radiography of the chest a soft tube is absolutely necessary. The tube should not back up more than a four inch spark gap between points. The exposure must be extremely short, never over two seconds at the most, as the slightest movement ruins a chest plate.

Lastly, an inexpert opinion on a radiogram is of no value whatever and sometimes is even worse in that it is misleading.

The Frequency and Cause of Primary Lung Carcinoma. P. Hampeln, M. D., Mitt. a. d. Grenzgb. d. Med. u. Chir. 36:145-150, Jan. 1923.

THE frequency of primary pulmonary carcinoma is increasing. In Munich there were only eight autopsy cases in the 31 years 1854-1885, while there was at least one case in each of the following nine years. A similar increase is found in the Dresden Municipal Hospital. The author brings data from a number of other cities confirming this increase. Among miners the rate of mortality from primary carcinoma of the lungs has been particularly great. Christiana, Norway is the only exception, as there have been only four cases there within the last twenty years.

The secondary metastatic carcinomata, however, retain the same frequency as heretofore. No increase is noted. While in former days in Christiana as well as at present the number of secondary cases was larger than that of primary cases at the present time, in the cities investigated by the author, the number of primary cases is greater.

This increasing frequency of primary carcinoma of the lungs in large cities, suggested to the author the possibility of an increased dust inhalation being the causative agent. Dust inhalation has been known to cause some lung diseases such as miners' phthisis, etc., so it is quite probable that the constant dust inhalation influences the new growth production by acting as an irritant either mechanically or chemically.

According to Schmorl the increase in lung carcinomata in Dresden is due to the sandstone and mining industries of that city. Pulmonary anthracosis and stone cutter's lung are very frequent there. Damaged bronchial glands, pigment eruption, scarification and stenosis, may give rise to carcinomatosis.

The fact, however, that many cases of primary carcinoma of the lung are entirely independent of the above mentioned industrial condition, but occur chiefly in inhabitants of the large city, is in the opinion of the author, of sufficient evidence to suggest ordinary increased dust inhalation as the cause. Among the author's 41 cases, mostly business men, were one teacher, two pharmacists, two physicians, one consul, and a few clerks and officials.

The author believes that the increase in city population, increased street traffic, increased smoke in the air and other similar factors, are responsible for the increased primary carcinomatosis of the lungs.

A. M. PFEFFER, M. D.

Present Status of Radium in Laryngeal and Oesophageal Cancer in the United States. Henry Hall Forbes, M. D., J. Laryngol. & Otol. 38:1-8, January, 1923.

THIS paper presents a brief summary of the literature and the conclusions reached by several radiologists of note.

Dr. T. J. Harris has expressed (1921) the opinion that radium is useful preoperatively, postoperatively and in inoperable cases but he believes that surgery, whenever possible, is the treatment of choice. Dr. Quick in discussing Dr. Harris' paper said that he believed that with improved methods in radium therapy it would attain a recognized position in the treatment of cases in which operation is doubtful. He considers a preoperative radium essential but is not so positive of the value of postoperative radium. Dr. Lewis of Philadelphia holds the same general views regarding this subject as does Dr. Harris.

Dr. Field of the Radium Institute, New York, stated that he preferred radium needles to suspension laryngoscopy, and he reported nine cases without recurrence for more than a year.

Dr. Freer of Chicago would try radium emanation in laryngeal carcinoma before resorting to laryngectomy or laryngotomy.

Dr. Mills of St. Louis, Dr. Simpson of Chicago, Dr. Hanford of Chicago, and Dr. Greene of Huntington Memorial report encouraging but not conclusive results in radium treatment of esophageal cancer.

The writer describes his own technique.

Endothermy, A Surgical Adjunct in Accessible Malignancy and Precancerous Conditions. George A. Wyeth, M. D., Surg. Gynec. Obst. 36:711-714, May 1923.

ENDOTHERMY was devised and developed by Dr. William Clark of Philadelphia and throughout a period of fifteen years it has steadily proved itself to be of greater and greater value.

It is "a treatment of accessible malignancy which greatly reduces the danger of metastases and the likelihood of recurrence by removing the growth as a necrotic mass instead of as a group of viable cells." The aim in endothermy is to destroy all morbid disease tissue before excising it. Constructive healthy growth then occurs in less time and with less suffering than is usually the case after the use of other forms of physical measures.

Endothermy is the production of heat in the tissues from within. It is a localized production of heat in response to oscillations of the high frequency current and surgeons use it for desiccating and coagulating the tissues. It is often loosely spoken of as the electric needle, the electric cautery, fulguration, diathermy, coagulation, sparking, but not any one of these terms fully describes it. Particularly the author

stresses the fact that endothermy is not fulguration.

In endothermy either the monopolar current (high voltage and low amperage) or the bipolar current (low voltage and high amperage) is used. The former produces desiccation, the latter coagulation. Heat may be applied where and to whatever degree is wished —"It can be throttled down practically to a pin-point area, permitting one to work in the cornea of the eye or in the vocal cords." It neither chars nor burns. The active electrode is cold when applied, the resistance of the tissues to the current produces the heat and is penetrative according to the strength of the current and the length of time applied. This is in contra-distinction to heat applied by the Paquelin cautery, the galvanocautery and fulguration as advocated by de Keating and Hart.

Monopolar endothermy is of great value in lupus vulgaris, all forms of tuberculosis of the skin and mucous membranes, vernal catarrh and leukoplakia. Epitheliomata can be removed and the method is of value also in precancerous dermatoses, including the various forms of keratoses, acanthoma, chronic ulcers, papilloma, fibroma, lupus erythematosus, and in x-ray dermatitis.

In monopolar work the needle lightly penetrates the lesion to be destroyed, but in deep seated malignancy bipolar endothermy is used and the needle is thrust to whatever depth is desired.

"Heat is generated by connecting one pole of the machine to a well-wet, indifferent electrode under the patient's buttocks as he lies upon the table. The other pole, the active electrode, is attached to the handle, in which is an ordinary sharp-pointed, steel darning needle of proper length and suitable shape. With this in hand any amount of coagulation necrosis can be described. In the squamous-cell variety of epithelioma and the more malignant and persistent forms of accessible cancer (particularly the lesions in and around the mouth, which metastasize early, are difficult of removal by the knife, and are uncertain in their response to physical treatment) endothermy is of the highest value. Lip lesions are removed under local anesthesia. Any portion of a tongue can be coagulated and immediately cut away. A floor-of-the-mouth cancer can be coagulated in situ and the necrotic mass removed in one operation. Bony structure, alveolus, hard palate and portions of the lower jaw likewise can be treated with the same degree of precision." Dosage is always under control and over treating is better than under treating which may stimulate growth.

If properly done there should be no hemorrhage but if it does occur it can be controlled by focusing the current for a second or two. Endothermy provides a protective ring of destruction around the malignant area, the blood vessels and lymphatics to and from the affected part are shut off and destroyed as are also the sensory nerves. After this has been done the lesion itself is destroyed and removed.

In hopeless cases the method gives great relief from pain and from the offensive conditions so often present; particularly in mouth conditions are these benefits appreciated.

Analysis of End-Results in Thyroid Surgery. Charles A. Porter, M. D., Surg. Gynec. Obst. 36:621-640, May 1923.

THE series here presented began in 1904. The author's summary of his article reads as follows:

1. "I believe that the x-rays through the action on the thyroid, and possibly on the thymus, will diminish the risk of operation and will permanently cure certain cases of Graves' disease. On the other hand I have seen cases in which x-ray treatment, though persisted in for as long as two years, has had practically no effect. Surgery promptly cured.

2. "If six months' treatment with x-rays is not effective, operation is indicated.

3. "The best index of a cure of Graves' disease is a permanent reduction of the basal metabolism to normal.

4. "Whether the patient will be cured or not depends on the stage of the disease at which treatment is instituted and the degree of irreparable damage which has already resulted.

5. "Though litigation and hemithyroidectomy may cure many patients, ultimate subtotal thyroidectomy most quickly and permanently reduces the metabolism to normal.

6. "The psychoses of this most interesting disease, which seems frequently to occur in neurasthenic individuals, requires long after treatment."

Further Observations on the Roentgen Ray Treatment of Toxic Goiter. J. H. Meand, M. D. and G. W. Holmes, M. D., Arch. Int. Med. 31:303-341, March 1923.

THIS paper includes description of methods, case reports and a mass of data thereon. The authors' conclusions are as follows:

1. "We believe that the data presented here show that the roentgen ray probably has a beneficial effect in toxic goiters, and that for that reason it has its place in our armamentarium for treating these diseases.

2. "About two-thirds of the patients with exophthalmic goiter so treated show either recovery or improvement coincident with the treatment. The remaining third neither improve nor grow worse.

3. "In exophthalmic goiter, when treated by the roentgen ray, if good results are not secured in a few months, surgery should be employed. Prolonged roentgen ray treatment in patients showing no response is undesirable. This is a fact which has been impressed on us particularly in our recent work. We have not emphasized it before, and therefore do so now.

4. "Some patients with exophthalmic goiter who are not cured by the roentgen ray are, perhaps, made better operative risks by it. A combination of the two forms of treatment may sometimes accomplish more than either does alone.

5. "In toxic adenoma there seems to be a similar improvement to that noted in exophthalmic goiter, surgery probably removes the actual cause of the disease, the adenoma. The indication for surgery would, therefore, seem more definite than in exophthalmic goiter. Even in toxic adenoma, however, in certain cases that are too thyrotoxic for safe operation, the roentgen ray may be used to advantage.

6. "To make a proper use of the roentgen ray in the management of toxic goiter of either variety, its limitations should be recognized and it should be intelligently correlated with other therapeutic measures as the individual case may demand."

Prompt Action of Radium Radiations in the Treatment of Small or Large Infected Tonsils and Lingual Tonsils. Francis H. Williams, M. D., Boston M. & S. J. 188:497, April 5, 1923.

DR. Williams reports great relief afforded patients suffering from infected tonsils when these are treated by radium. The treatment is harmless and its use for the last two years has proved satisfactory. Operation can often be avoided and this is at times desirable.

The Diagnosis and Treatment of Thyroid Disease as Controlled by the Metabolic Rate. Albert H. Rowe, M. S., M. D., Endocrinology 7: 257, March 1923.

THIS paper gives neither unqualified praise nor unqualified condemnation to x-ray therapy used in hyperthyroidism. The author says that a goiter should not be treated by x-ray after the metabolic rate has become normal or when it is fast approaching normal, neither should the rays ever be administered when a crisis is approaching as

indicated by an increased metabolic rate and symptoms, nor when the rate remains stationary at a high level of 80 per cent or more; if the rate is 70 per cent and is increasing radiation should not be used; medical treatment should be given to lower the rate before radiation is given. The author has drawn this latter conclusion from the unfortunate termination of three such cases in his practice.

Finally, whenever x-ray treatment is used the results should be checked by repeated tests of the metabolic rate.

Report of a Case of So-Called Marble Bones with a Review of the Literature and a Translation of An Article. William G. Alexander, M. D., Am. J. Roentgenol. 10:280-300, April 1923.

THE author reports the case of a woman, 43 years of age, in whom there was such a high degree of calcification of all the bones of the body that they presented a stone-like picture, although without any change from normal contour. At first examination the author found himself at a loss to explain the condition in any way. Not long after the patient had reported to him, however, there appeared in the German literature a report by Fritz Schulze of six similar cases which he had found in a search of German literature. Portions of this report are reproduced in the article here abstracted and give details of the six cases, patients of Schulze, Sick, Lorey, Albers-Schoenberg, Laurell and Wallgren.

The etiology of this condition is not known although it is thought by Dr. Alexander that a disturbed kidney function may account for it. The changes found allowed no definite classification under any known disease of the skeleton; osteomalachia, rickets, etc. were all ruled out.

The Diagnosis of Sarcoma in Bone. Eugene H. Ewing, A. M., M. D., J. A. M. A. 30:1429, May 19, 1923.

GENERALLY speaking, new bone resulting from an inflammatory process will be found laid down in lines parallel to the axis of the bone, but when due to neoplastic irritation it is found in plaques or spicules at right angles to the axis.

The author says that the x-ray picture of bone sarcoma must be studied from the standpoint of bone striving to protect itself against invasion, and not from the standpoint of the tumor alone.

In very early pathology the changes in the bone do not show in the plate (not for a week in osteomyelitis, and not for much longer in neoplasms.)

Complaint is made that in the literature of bone pathology one finds a confused terminology, incomplete clinical reports, too few histological examinations and a single roentgenogram when a series should have been made.

Roentgenological classification of bone pathology has not yet been satisfactorily done. The author believes that in the nature of the tissue there never can be any hard and fast rules laid down for roentgenographic diagnosis of bone lesions.

An Efficient Method of Applying Radium within the Mouth. E. Wood Ruggles, M. D., J. A. M. A. 80: 1374, May 12, 1923.

IT is not only wearisome to hold radium in one position for hours when treating an oral lesion but it is practically impossible to hold it in exact position for any great length of time.

The author hit upon the device of attaching a radium plaque to the end of an ordinary white pine tongue depressor by means of adhesive plaster, then placing a similar depressor exactly opposite on the outside of the mouth. A rubber band was twisted two or three times to give adequate pressure and was slipped over the outside of the depressors to about the middle point. A block of wood about one-half inch thick was then inserted between the outer ends.

The device works very satisfactorily. The pressure produces neither pain nor great discomfort and the plaque remains in exactly the same location indefinitely. In treating lower lip lesions a cord can be looped over the head and attached to the ends of the plaque to avoid downward tension on the lip.

Cancer of the Prostate. George Gilbert Smith, M. D., Boston M. & S. J., 188:621, April 26, 1923.

OBSERVERS best qualified to know estimate the percentage of prostatic cancer at 20 per cent. Wilson, McGeath, Judd and Young are cited as agreeing in this estimate.

For any success in treatment early diagnosis is necessary and must be followed by surgery with radium as an adjunct. Radium alone is not sufficient. If used alone and in a powerful enough dose to kill the cancer there will be a sloughing, infected area without sufficient drainage.

The Clinical Results of the Treatment of Malignant Disease by X-Rays. J. H. Douglas Webster, M. D., M. R. C. P., Physician in Charge of the Department of Radiology, Middlesex Hospital, London. The Lancet, 204:373-378, Feb. 24, 1923.

RESULTS of radiation treatment should be tabulated according to the aim of treatment whether prophylactic, palliative, or curative. Any other basis of judgment is not a fair one.

In superficial basal cell epithelioma the aim is curative and cure will result in the majority of cases properly treated. Failure may result from several causes, among which may be mentioned failure to irradiate sufficiently the deeper strata of cells, failure to include a wide enough area beyond the visible and palpable extent of the lesion, and failure for any reason whatsoever to follow up cases which are apparently clinically well.

In squamous cell epithelioma results are not so good as in the superficial basal cell type, as frequently there is early wide invasion and the primary tumor is very resistant.

In breast cancers so many factors are involved and statistics leave out so much that is vital that it is difficult to present any sure conclusion except to say that in general the best results follow surgery plus radiotherapy. A very condensed but albeit comprehensive review of the literature is given.

In growths of the mediastinum a few clinical cures are reported and a large proportion of cases have shown temporary benefit. Testicular and prostatic cases are difficult although some encouraging reports have been received.

In gynecological conditions practice and opinion differ widely. The literature upon this subject is also rather extensively reviewed in a condensed form.

Gastric cancer was first to be treated by x-ray therapy (1896) and will probably be the last to yield to that or any other form of therapy. Radiation is advised, however, after partial gastrectomy. Surprising results sometimes follow treatment of primary cases.

X-rays should be tried in the following sarcomata: All inoperable cases (even glio-sarcoma of the brain); lymphosarcoma; periosteal sarcoma of the pelvis, shoulder or limb joints; myelogenous sarcoma and skin sarcoma should first be radiated and later, if necessary, surgery may be resorted to. Maxillary sarcomata are difficult to radiate and should be operated if this is possible.

In general what the author considers cautious, progressive present-day opinion is thus expressed (from Schmieden): "(1) With few exceptions every operable carcinoma should be operated upon, with prophylactic postoperative radiation in addition. (2) In addition to postoperative radiation a single intensive radiation before operation is coming to be considered important. (3) Practically all inoperable carcinomata and all inoperable recurrences should be radiated. This gives in many cases clinical cure, in others it results in opera-

bility, often less bleeding, irritation and pain, as well as limitation of further metastases. (4) Facial carcinomata, even when operable, can well be treated exclusively by radiation, for cosmetic reasons. (5) Sarcomata, as a rule, should only be radiated, certainly in all cases in which operation would cause considerable bodily mutilation. (Any increase in size of the tumor after an efficient radiation should not be considered proof of failure to respond, it is usually only temporary)."

There are at least six possible lines of advance in radiation therapy and the author thus describes them: "(1) In the engineering and electrical workshop, improvement of apparatus in power and reliability. (2) In the physical laboratory much remains to be done with measurements of dosage, standardization, calculation of scattered radiation and absorption in animal tissues, * * * the physical side of biological radiation effects; (3) In the postmortem room and the pathological laboratory, more statistical and experimental work; apart from immunity and gross animal tumor work, the histological reactions to radiation, as Ewing says, seem to require the combined genius of a Waldeyer, a Weigert, and a Virchow to elucidate them; here new methods like vital staining may be of use; and there is a very wide range for biochemical investigation as to the radiation effects on basal metabolism, etc.; (4) Clinical technique is a most important branch requiring much further working out. * * * Auxiliary technique such as diathermy, ionization, radiation stimulation (ductless gland) dosage, or general minimal repeated radiation or other means for stimulating the patient's immunity requires much further research. (5) In relation to surgery * * * Much still has to be learned as to the value of pre- or postoperative radiation, or both * * (6) Finally, auxiliary medical measures require much further investigation; though about 100 substances have already been tried, still in this sphere, some day, may be discovered what may displace both surgery and radiation in the treatment of malignant disease. At present the general management of the cancer patient is too often neglected; open air, exercise, diet are not unimportant in recovery, and the role of hematinics, colloid, protein, and animal extract injections or transfusions, and of drugs such as arsenic, iodide, etc., is little understood yet."

Pneumoperitoneum. Humberto H. Carelli, M. D., Am. J. Roentgenol. 10: 259-279, April 1923.

DR. Carelli has employed pneumoperitoneum in the examination of more than 800 patients and in no case has there followed any ill effects. The ill effects ascribed to the method by others who have used it he ascribes to faulty technique, lack of proper equipment or lack of a thorough clinical examination beforehand.

The needle must be entered at the right spot and one must wait to see that blood does not flow through the needle. The simplest rules of asepsis will prevent peritonitis. Contra-indications to the use of this method are cardiovascular troubles or insufficient myocardium, old age (as a rule), cachexia, extreme obesity, acute inflammations of the abdomen, hysterical tendency, also the method must not employed in those patients where a tumor or tension does not permit further extension of the abdominal wall.

The shock to the patient is far less than that of exploratory operation, and the results are far more comprehensive.

Technique: A purge is given for two successive mornings, castor oil the first day and a saline purge the following one. The patient is kept upon a watery diet these two days and upon the third day the intestines and bladder are emptied and the examination is made.

A long thin platinum needle is introduced into the abdomen at a point one or two finger breadths below the naval on the linea alba. If there are scars here from a previous operation, then the needle must be introduced elsewhere. If blood does not flow the needle is then connected with the tube conveying the oxygen, which is passed in rather slowly, from two to eight liters being used according to the size of the abdomen, flaccidity of the walls, etc. The patient must not be allowed to alter his movements by himself during the examination. After the examination the oxygen is withdrawn by a flat trocar and the patient gets down from the table without assistance and without complaint.

Perirenal Insufflation is thus described: "After having taken a first roentgenogram with metal guiding points on the patient's skin, one fixes on the point which corresponds to the transverse process of the second lumbar vertebra.

"A fine platinum needle, 10 to 12 cm. in length, is introduced down to this process (of cource according to the rules of asepsis). As soon as this process is encountered, the needle is made to deviate so as to avoid it, while watching the manometer of the injecting apparatus, and as soon as the manometer shows oscillations, one knows for certain that the needle has entered the perinephric cellular tissue. One then commences to inject the gas which is to produce the artificial emphysema.

"This injection is made with a Forlanini apparatus or the *Oxygenateur de Precision du Docteur Bayeux*. I used to employ carbonic dioxide, but I found that the absorption was so rapid that it did not allow sufficient time for taking several plates. For this reason I now use oxygen instead of carbonic dioxide.

"This operation is not painful. The patients experience a certain amount of discomfort in the lumbar region, but that ceases within an hour.

"The quantity of oxygen one injects varies from 200 to 600 c.c. according to the size of the patient."

The text of this article covers about three pages, the remaining 17 are occupied by 87 illustrations, mostly of pathology as revealed by the method.

The Importance of Pyelography in Recognizing the Causes of Obscure Abdominal Symptoms. Richard F. O'Neill, M. D., Boston M. & S. J., 188:671, May 3, 1923.

PYELOGRAPHY, while not free from danger and discomfort, is a useful and necessary procedure at times, and the dangers may be minimized to a great extent.

The author uses sodium iodide, 12½ per cent solution, in his work. The patient should be hospitalized as it is necessary that he be kept quiet for several hours after the procedure. The fluid is injected slowly and injection is stopped as soon as any indication of discomfort appears as the restlessness and possible internal spasm resulting from discomfort may spoil the picture.

Simultaneous bilateral pyelography is not regarded as wise, as alarming anuria may follow. If desired the second picture should be taken at another sitting. An ureterogram as well as a pyelogram should be taken in all cases. This is done by withdrawing the catheter and injecting the ureter.

Pyelography should not be performed in cases complicated by tuberculosis, acute urinary infection, nor in large hydronephrosis when the diagnosis is obvious by ordinary ureter catheterization; neither should it be done in the presence of cachexia nor in those patients who react violently to instrumentation.

Mistakes in interpretation are easy to make in this work. Often what appears to be an abnormal renal pelvis may be a filling defect due to an insufficient injection (inject more fluid and develop plate at once). A blood clot in the renal pelvis may lead to a mistaken suspicion of renal tumor.

Three case reports are submitted. These are of patients who complained of pain in the upper quadrants of the abdomen but in whom physical examination was negative and in whom no urinary symptoms were found but upon

pyelography pathology was revealed in the urinary tract. In these cases the symptoms were thought to be due to pathology elsewhere.

Occasionally a tumor or cyst may be found involving the lower pole of the kidney without encroaching upon the renal pelvis. "Here we might have a normal renal pelvis and the pyelogram would fail to show any lesion of the kidney. Such cases are rare and the diagnosis will have to be made by palpation or x-ray or by exploratory operation. Such a cyst or tumor in the upper pole would cause a downward displacement of the kidney, which would be at least suggestive of renal involvement although such displacement might be caused by a retroperitoneal tumor."

Principles of Radiotherapy of Carcinomata Especially of Uterine and Mammary Carcinomata. E. Opitz, M. D., Am. J. Roentgenol. 10:312-319, April 1923.

THE author's summary is as follows:

1. "Retrogression of the cancer is not solely due to the local action of the rays, but it is to be considered as a function of the whole organism that has been attacked by cancer. The organism is activated by the irradiation.

2. "The elements of these activating forces are contained in the healthy tissues surrounding the cancer, the blood, and probably also the endocrine glands, including the spleen (reticular-epithelial apparatus.)

3. "A carcinoma dose according to the definition of Seitz and Wintz, that is to say, a curative action upon every variety of cancer by a dose of rays of from 90 to 100 per cent of the erythema skin dose, does not exist. However in the majority of the cases of mammary and uterine cancers a retrogression may be expected from the administration of this dose (Holzknecht). This carcinoma dose proposed by Kroenig is therefore still useful.

4. "Experience teaches that frequently repeated irradiations with a dose which does not quite reach the amount of the carcinoma dose are productive of the best permanent results. The most favorable results are observed from a combination of radium and x-rays.

5. "An over-dosation is to be considered as especially dangerous because it weakens the local as well as the general defensive forces of the body.

6. "The posological question requires an elucidation on account of the systemic action of the rays.

7. "The therapeutic effects of irradiation can be augmented by the employment of various auxillary remedies." (The main text explains that this is not accomplished by copperization but by catalytic or other activating means).

8. "The best results are only obtainable if the method of irradiation is adjusted to the particular conditions of each individual case."

Deep X-Ray Therapy in Gynecology. Report on the Obstetrical Section of the Royal Academy of Medicine in Ireland, February 23rd. Brit. M. J. 2:418, March 10, 1923.

DR. G. E. Pepper in his paper described the "symmetrie" apparatus of Seitz and Wintz. The essential points of this apparatus are the division of the coil into two symmetrical parts, "and the inclusion in the circuit of two water resistance tubes, with an inclosed point and plate spark gap so as to destroy all oscillations and inverse currents and to prevent formation of poisonous gases."

He emphasized the great necessity and also the difficulty of measuring the dosage and estimating the penetration of the rays by means of the water phantom.

The combined use of x-rays and radium was advocated in treatment of malignancy.

The action of x-rays on malignant cells is said to be due to the ionization which causes lecithin to split up and liberate cholin which poisons the cells.

An Instrument for Measuring Distortion Due to the Divergence of X-Rays. Eben C. Hill, M. D., Bull. Johns Hopkins Hosp. 34:164-168, May 1923.

DIAGRAMS illustrating the apparatus are given in the original paper which discusses the necessity of measuring the distortion, relates experiments and the history of the evolution of this device and gives a description of it. The author's summary is quoted below:

1. The development of stronger, more dependable x-ray tubes and machines, together with such accessories as the intensifying screen, has made possible at last a study of divergence of roentgen rays.

2. A movable diaphragm has been introduced and later modifications were made. These diaphragms remove to a certain degree the effects of secondary radiation and distortion, but there is no method for direct correction of errors.

3. The many sources of errors in diagnosis due to distorted images from the secondary and broad focus rays and to various other mechanical conditions are discussed.

4. A description, with illustrations, is given of an instrument which has been found to give accurate scientific measurements. Its usefulness is in no way dependent on the time element so necessary in the diaphragmatic devices and there is no complicated synchronism between the length of exposure and the movement of the diaphragm.

5. Calipers applied to shadows of the measuring plates and the scale quickly gives the actual errors in the shadows of the part radiographed.

6. The simplicity of the instrument is self evident. By its use, in wrist measurements, where radiographic determinations at a one meter target distance as compared with dissections of the same parts showed about eight per cent error, exact control was afforded.

Concerning the Changes and the Outlook in Radiotherapy. Otto Strauss. M. D., Deutsche med. Wchnschr 48:1574, Nov. 24, 1922.

DR. Strauss points out that there is really no "carcinoma dose" and that though in certain forms of pathology a certain dose is almost sure to give a result practically identical in each case, yet the term, even for a specific pathology, must be understood as only approximate in meaning.

Large doses having been found injurious to the general resistance of the body, many workers have reduced the dosage. The author does not concur in this practice; he believes that strong dosage is necessary in the primary tumor and that in postoperative treatment, much weaker ones should be used, to stimulate general resistance. He advances the theory that the secret of successful cure may be found in the quality of rays rather than in the quantity. He does not regard as plausible the theory that large doses are injurious to the endocrine system.

As to the part played by connective tissue in the destruction of cancer cells, the author believes this has been overestimated. If the chief effect of x-rays were secured through the connective tissue then scirrhus forms of malignancy would be the most benefited by treatment—which is not the case.

The Use of Radium in the Treatment of Disease. Dawson Turner, M. D., Brit. M. J. 2:464, March 17, 1923.

IN the Edinburgh Royal Infirmary the principal conditions in which radium has been found useful (besides in malignancies) are exophthalmic goiter, splenomedullary leukemia, Hodgkin's disease, keloids and nevi.

The most amenable of these are rodent ulcers, epitheliomata, lympho-sarcomata, spindle-celled sarcomata, malignant disease of the cervix, sarcomata of the nasal passages, exophthalmic goiter, early keloids, and certain nevi.

Barium Plaster Protection Used in the X-Ray Department of the Manchester Royal Infirmary. From "The Organization and Equipment of An

X-Ray Department" by A. E. Barclay, M. D., J. Roentgen Soc. 19: 55-78, April 1923.

AN abstract of Dr. Barclay's paper was published in the March number of the Journal (see page 95). In this paper the substitute for lead was made mention of. The formula is here given and is as follows:

1 part commercial barium sulphate
1 part Portland cement
1 part sharp well-washed sand

This is mixed dry and water added as necessary. Lay on plaster to half an inch at first, and when dry finish up to three-quarters of an inch. The wood framing should be covered with lead unless provision is made for allowing the plaster to cover it.

Plastering one side of the wall ¾-inch thick gave a minimum lead-equivalent of 3.5 mm. and a maximum of 4.5 mm., at least it was so thought at first but subsequent measurements by the National Physical Laboratory gave lower figures. The treatment cubicles were plastered on both sides a total thickness of 1½ inches of plaster and these tested an average of 8.5 mm. lead.

Since the first report of this new laboratory was made the red lights of the dark room have all been replaced with the new Thorne-Baker green glass giving an extraordinarily plentiful, slightly green light which is proving itself to be most satisfactory.

Some Points in the Physics of the X-Ray Tube. G. W. C. Kaye, O.B.E., M.A., D.Sc., J. Roentgen Society 19:84-87, April 1923.

NO difference in principle exists between the x-ray tube of 1895 and that of today. It still remains a device for generating high velocity electrons and suddenly depriving them of that velocity by hurtling them against a target. In an apt figure the electrodes are likened to shells which burst, and in place of flames x-rays break forth.

The factors controlling the output of the general or continuous spectrum of rays are: "(a) the number of the cathode rays or electrons which strike the target, (b) the speed of the electrons, (c) the massiveness of the target: (a) is represented by the current through the tube, (b) by the voltage across the tube, (c) by the atomic weight, or more precisely, the atomic number of the metal of the target."

The x-ray spectrometer shows that the x-ray output is proportional to the current, to the atomic number of the target and to the square of the voltage.

Applied voltage dominantly affects the output and is the only arbiter of quality or penetrability or wave length, and it must be measured routinely every day.

It is becoming more and more necessary to discard the terms "hard" and "soft" rays and to speak of wave lengths and the author suggests that radiologists might "make a beginning, for example, by agreeing that 'hard' rays refer to rays with wave lengths shorter than 0.1 Angstrom units and that 'soft' rays have wave lengths longer than 0.3 Angstrom units, the intervening rays being of 'medium' hardness."

The chance that an electron in an x-ray tube will come into suitable conflict with an atom of the target and thus generate x-rays is only 1 in 1000; the electric energy is more apt to be frittered away in heat. If the electron does strike an atom of the target it will either lose all its energy at one encounter or will lose it by installments in a succession of encounters, i. e., it may lose all of its original driving voltage in one step or in a number of steps.

The wave length of the x-ray generated is inversely proportional to the amount of energy (propelling voltage) lost. If all energy is transferred by one encounter then the result will be the shortest wave length x-rays possible to that voltage. These rays will of course be accompanied by a variety of wave length x-rays possible to that voltage. These rays will of course be accompanied by a variety of wave lengths depending upon the energy lost by other electrons which have not lost all their energy at one contact.

Thus it is seen that constant potential does not produce homegenous x-rays even when all electrons hit the target with the same velocity. However, the efficacy of constant potential is superior as the x-ray spectrometer proves. If the potential is constant the proportion of short waves is greater than if the potential were fluctuating, the peak value of which is equal to the constant potential.

Furthermore it is shown by the spectrometer that the minimum wave length in Angstrom units multiplied by the maximum voltage is equal to 12, 350. This scale though perhaps not perfect is more exact than any which is generally used. In a typical spectral curve of x-ray emission the shortest waves dominate, especially if the normal type filters are employed. The mean effective wave length of a spectrum of rays approximates the wave length of the peak of the curve, i. e., the wave length of maximum density. It is thought that the peak wave length of the peak is proportional to the limiting (quantum) wave length and so the quality of a mixed bundle of rays can be fairly well identified. Standardization of application and technique so as to use only three or four spectra the distinctive features of which could be determined and specified would enhance the precision of this method.

There are many difficulties to be overcome before the new 500,000 volt tubes can be put to practical use. A more robust x-ray tube will have to be provided. There is room, in fact in almost every section of x-ray equipment, for improvement. The overall efficiency of present x-ray equipment is of the order of 1:800,000 assuming that half the rays emitted by the bulb are utilized.

The ideal in radiography as expressed by the author is: "To make the process as simple and noiseless as taking an ordinary photograph. The patient should hear nothing untoward, the apparatus should look no more formidable than a camera. Sparks and brush charges should be taboo; the rumble of rotating machinery anathema. Standardized technique must be the order of the day for much of the radiographer's work. The number of variables must be cut down."

Standardization of X-Ray Exposure Identification. Edw. S. Blaine, M. D., Am. J. Roentgenol. 10:303-306, April 1923.

ANY system of marking films which permits of mistaken identification of any film may lead to serious consequences. One illustration cited is of an operation done for renal stone where none was present, all due to the films of two patients having been confused.

The vital requirement is that the identification be exposed upon the plate or film at the time the exposure is made of the part examined. To determine rights and lefts without special markings the marker should routinely be placed facing the tube target no matter what the position of the plate. The following information should be given indelibly:

Name of hospital, city, roentgenologist, date of exposure, name of patient, name of referring physician, serial number of case.

A stencil machine can be operated at little cost to produce the necessary markings.

In justice and fairness as well as for medicolegal reasons, inerasable, indelible markings should be used.

Simulation of Diverticulum of the Duodenum by a Calcified Mesenteric Gland or by Calcification in the Intestinal Wall. Dr. Lotsy, Cairo, Egypt. Fortschr. a. d. Geb. d. Roengenstrahlen 30:212-214, February 1923.

IN the course of a routine gastro-intestinal examination a rounded opaque shadow was observed which was partly within the shadow of the visualized duodenum and partly outside of it. Manipulation failed to separate

that shadow from the one of the duodenum, although it could be moved about freely. This shadow remained even after the onward passage of the contrast meal which passed alongside it.

Differentiation: (a) Right renal calculus was excluded by the free movement of the shadow on manipulation.

(b) There were several arguments against its being a biliary calculus. First, the nature of the shadow; instead of a lesser opaque central cholesterin shadow within a more opaque calcium covering, this was a strongly calcified homogeneous opacity. Secondly, such a strongly calcified calculus could only have been present in an inflamed gall-bladder which would not permit such free mobility. There were no symptoms of cholecystitis or an enlarged liver with palpable gall-bladder.

(c) The highly marked homogeneous calcification and the sharp outline of the shadow was against the probability of a calcified mesenteric gland.

The fact that manipulation failed to separate the opacity from the duodenal shadow, that the meal passed alongside it, and that it remained after the complete evacuation of the meal, suggested the diagnosis of a duodenal diverticulum as highly probable. Unfortunately no examination was made previous to the ingestion of the barium suspension.

Three weeks later the patient reappeared for examination. The opacity was still present—this fact being sufficient to eliminate the probability of a diverticulum.

This patient had had a long standing bilharziosis, and the author assumed that the shadow represented either a calcified mesenteric gland or a calcification of Bilharzia ova in the wall of the duodenum.

A. M. PFEFFER, M. D.

The Pulsatory Movements of the Diaphragm. Karl Hitzenberger, M. D., Wien. Arch. f. inn. Med. 5:451-472, January 1923.

THE literature on this subject is reviewed by the author.

Schwarz and Dietlen observed (roentgenologically) rhythmical, systolic twitching of the dome of the diaphragm in some cases of pleuropericardial adhesions, and concluded that in those cases there must have been some adhesion between the apex, and the pericardium. This phenomenon was observed only in the left diaphragm.

Achelis noted this phenomenon in adhesive pericarditis even when there were no visible adhesion bands between the heart and the diaphragm.

Bordet and Vaquez observed tension of the diaphragm with every systole in cases manifesting the Broadbent signs. Cohn was the first to describe pulsatory shaking of the diaphragm and the visualized stomach in aortic insufficiency.

Holzknecht observed a type of right diaphragm movement peculiar to tricuspid insufficiency, a pulsation transmitted by the venous liver pulse.

In his own investigations the author found that the pulsations of the diaphragm which can often be observed in healthy people, and which are more characteristic in the above mentioned pathological conditions, are best elicited in experium with cessation of breathing. The author explains this phenomenon by the fact that in inspirium the diaphragm is in marked tension and does not respond to lightly transmitted movements while in expirium it is in a relaxed condition.

Pulsations of the right diaphragm are best elicited with the patient on the left side.

Using various methods, such as the combination of apex palpation or auscultation with screen observation, the author was able to time the pulsatory movements of the diaphragm with relation to the systole and diastole of the heart. He made observations on the normal subjects, and in subjects with various types of cardiac pathology.

The following summary was made by the author:

1. Under physiological relations one can observe pulsatory movements of the diaphragm, particularly distinct in the right side, in the standing subject in the expirium. The pulsations correspond to a negative venous pulsation of the liver. Their components are a slow presystolic upward movement and a rapid downward movement. The first component corresponds to the "a" wave, while the second one corresponds to the systolic collapse of the normal venous pulse.

2. The left diaphragm is to be considered in two separate parts: the medial, lying beneath the heart, and the lateral. The first one pulsates more strongly in inspirium and rises with the heart systole. The lateral is at rest or follows the medial portion, less feebly.

3. In valvular defects with the exception of tricuspid insufficiency and auricular fibrillation the diaphragmatic pulsations are the same as in the normal.

4. In tricuspid insufficiency one can observe a systolic and diastolic rise and fall of the right diaphragm as the expression of the positive venous pulse.

5. The pulsations of the right diaphragm in auricular fibrillation are of the same nature as in tricuspid insufficiency in the presence of a positive liver venous pulse, otherwise the fall is not in diastole, but in systole.

6. Pulsations are changed in presence of anomalies of the position of the diaphragm.

7. In pleuropericardial adhesions in the right cardiohepatic angle, one sees upward twitching of the right diaphragm in systole.

8. Obliteration of the pleurae and fixation of the diaphragm to the thoracic wall abolish pulsations of the diaphragm.

A. M. PFEFFER, M. D.

Effects of Irradiation on Fetal Development. Harold Bailey, M. D. and Halsey J. Bagg, Ph. D., Am. J. Obst. & Gynec. 5:461-473, May 1923.

THE authors thus summarize this paper: "We have attempted in this paper to bring together the experimental and clinical studies relating to the effects of radium and x-ray irradiation upon the functional activity of the ovary and the reaction upon the developing fetus, when irradiation is given before or during the various stages of pregnancy.

"As previousiy stated in detail, the experimental data upon the lower animals have shown that when the sex glands are sufficiently irradiated *before* fertilization the following are typical fetal reactions:

1. Disturbed, abnormal, arrested development, resulting in the formation of monsters conforming more or less to a general type, and pronounced disturbances in the development of the central nervous system (Bohn, Perthes, O. and G. Hertwig, Schaper, Tur, Bordier and Baldwin).

2. A marked tendency to a progressive loss of fertility.

3. A specific modification of the hereditary mechanism (Mavor) and the production of inherited defects in the young, especially in the eyes (Little and Bagg).

"Irradiation during pregnancy produces the following typical disturbances in fetal development, depending upon the developmental period at which the irradiation is instituted: Disturbed, arrested abnormal development with death of the embryos, absorption or abortion, stunting in growth, cataract, sterility, lesions of the central nervous system and blood vascular disturbances in the embryos (Hippel and Pagenstecher, Regaud, Nogier and Lacassagne, Lengfellner, Krukenberg, Cohn, Walter, Bagg, Hansen, Lacassagne and Coutard).

When we come to a discussion of the clinical reports it must be borne in mind that the data cannot be presented with the same scientific evaluation that may be given to experimental biologic studies, and although we realize that one cannot directly transfer the experimental results from animal to man, yet we believe that there is no reason for considering human developmental pro-

cesses as essentially different from those of other mammals, and it has been our aim to bring together the clinical reports to interpret and correlate them as much as possible, and to add our six cases. We are fully aware that developmental disturbances are to be found in many instances of human ontogeny where irradiation has never been applied, and we wish to caution those who contemplate the irradiation of women during the child-bearing period with a view to preserving the procreative ability.

"In judging the clinical reports we believe that in those instances where comparatively great disturbances have resulted in the child, the irradiation was given early in pregnancy. Here we would place the children with subnormal mentality and other defects reported by Aschenheim and Stettner.

"We believe that irradiation during early pregnancy may produce death and abortion of the fetus, and we would place in this group the four abortions reported by Clark and Keene, two by Stacy and nine by Werner.

"Irradiation in late pregnancy is not so likely to produce gross developmental abnormalities in the child at birth, but the clinical data seem to agree with the experimental in several instances where children irradiated *in utero* at this period have been prematurely delivered, or have shown postnatal growth disturbances, or death within the first year. Werner reported three such retarded children, and four that died during the first year. The second child we reported was born of a mother who was irradiated very thoroughly late in pregnancy, the child was apparently normal at birth, but died when ten weeks old.

The severity of the treatment, as well as the period in development when the irradiation was given, no doubt determines the reaction of the fetal tissues. Our third case was treated during the fifth month of pregnancy, and then only locally, an effect largely due to beta ray radiation within the vulval tumor. At the eighth month the mother was treated over the vulva with gamma ray radiation which was equivalent to 50 per cent of the skin dose. The treatment was not severe, the fetus was not directly irradiated, and the child was apparently normal at birth and has remained so to the present time.

"The second division of this study relates to the irradiation of women before conception where complete sterility is not produced. The experimental evidence in the lower animals shows with great probability that irradiation injures the follicular elements of the ovary. The first patient we reported was suffering from Hodgkin's disease and ten months before conception was heavily radiated with x-rays. A male infant was born with an extensive developmental arrest in the formation of the head and died after a few hours. The second patient was irradiated for a fibroid with gamma ray radiation both from within and outside the uterus, and she became pregnant eighteen months later. In this instance a large stillborn infant was born at term. Our last case was also irradiated with a gamma ray radiation from a platinum tube placed in the uterus. Conception occurred seven months later, and the child was apparently normal at birth. Our own evidence is not sufficient to warrant our attributing the developmental defect in the first case, or the stillbirth in the second as due to irradiation.

"Archangelsky irradiated with x-rays ten women suffering from tuberculosis, with the intent of producing abortion, and was successful in seven instances. This evidence is apparently conclusive that irradiation during early pregnancy may produce death and abortion of the fetus. The abortions reported by other clinicians and mentioned above can hardly be considered as additional evidence because we do not know in these cases the condition of the uterine wall or other pathologic conditions.

"It is questionable whether radium or x-ray irradiation should be used to destroy the ripe follicle leaving the immature ones injured but capable of development. This statement is made entirely on the strength of the experimental work on the lower animals and we do not feel justified in considering any of the available clinical records as adding conclusive evidence in this regard. In the treatment of menorrhagia in the child-bearing period we believe that complete sterility is preferable to the possibility of a damaged germ plasm.

"Irradiation of the ovum during early pregnancy should never be permitted. Radiation in late pregnancy, while it may not produce gross abnormalities at birth may hinder the growth and development of the child in later life."

Roentgen Ray Treatment of Skin Diseases. Clyde K. Halsey, M. D., M. Clinics N. America, 6:1155-1164, March 1923.

THE x-ray treatment of skin diseases as carried out at the University of Michigan Hospital during the last three years are here presented. The method is mainly that of the late Dr. Van Zwaluwenburg and differs from the method outlined in Mackee's *X-Ray and Radium Treatment in Diseases of the Skin* in the filter and in the use of a longer spark gap and higher ma. The techniques of Hazen, Witherbee and Reamer have been followed on some dermatoses.

The following lesions are discussed with relation to technique of treatment and to results which may be expected: Superficial malignancies, senile keratoses, acne vulgaris, dermatitis papillaris capillitii, mycelial dermatitis, eczema, favus, sycosis vulgaris, tinea barbae, tinea tonsurans, onychomycosis, verruca vulgaris, verruca plantaris, granuloma fungoides and prefungoid stages of granuloma fungoides, leukemia cutis, hemangioma, lymphangioma, leukoplakia, lupus erythematosus, lupus vulgaris, folliculitis, paronychia, acne rosacea, bromidrosis, hyperidrosis dysidrosis.

Besides these which are specifically discussed the following are named as lesions which have been treated at the hospital: actinomycosis, angioma, blastomycosis, callosity, cheilitis glandularis, clavus, condyloma acuminata, dermititis coccidioides, dermatitis exfoliativa, dermatitis venenata, erythema induratum granuloma annulare, keloid, lichenification, lichen planus, melanotic sarcoma, nevus, onychomycosis, pruritis (general and specific forms), rhinophyma, scrofuloderma, seborrheic dermatitis of face and body, sporotrichosis, tuberculosis verrucosa cutis, verruca seborrheica, verruca vulgaris.

The author concludes by saying: "Roentgen rays, properly applied, are the most useful single therapeutic agent a dermatologist has in the treatment of skin conditions. He issues the warning, however, that extreme care must be exercised in its use. Proper equipment and technique are indispensable to safety, and in no case should treatment extend over six months.

Treatment of Chronic Eczema with Concentrated Carbon Arc Light (Finsen). Svend Lomholt, O. B. E., M. D., Finsen Institute, Copenhagen. Brit. J. Dermat. 35:45-49, February 1923.

X-RAY treatment of chronic eczemas fails completely or partially in some cases, there is always danger of relapse, and repeated treatments not only fail to have the efficacy that the first ones showed but they involve a risk of permanent danger to the skin.

Finsen treatment is rather a laborious and expensive form of treatment, says the author, but if x-ray treatment fails to show definite results after the first treatment then the Finsen light should be employed for these lesions. Results with it have proved most remarkable in chronic eczemas as proved by the striking case reports presented here. Relapses may occur but as the repeated applications will do no harm to the skin, treatment may again be employed and cure result. It has the advantage of combining well with all other well known local forms of treatment of this lesion.

Carbon-Arc Light Baths in the Treatment of Lupus Vulgaris. J. H. Sequeria, M.D., F.C.R.P., F. C.R.S., Physician to the Skin Department and Lecturer on Dermatology at the London Hospital. Brit. J. Dermat. 35:93-98, March 1923.

THIS paper reports 70 per cent permanent cures (10 to 20 years); 11 per cent temporarily cured but requiring treatment from time to time for slight recurrences which in most cases finally ceased; 16 per cent benefited but not cured, and about 3 per cent intractable.

The effects produced are intense pigmentation, rapid healing, increase in body weight, improved general condition and in some cases increase in lymphocytes.

The spectrum of carbon light more nearly approaches sunlight than does any other form of illumination and there is no need to inclose the light in an envelope of inviol glass or rock crystal. The Danish government is so satisfied with the efficacy of this form of treatment that it pays for maintenance of patients who take the treatment.

The Treatment of Vascular Nevi with Radium. R. H. Rulison, M. D., and Stafford McLean, M. D. Am. J. Dis. Child. 25:358-370, May 1923.

FROM the standpoint of radium therapy the authors divide vascular nevi into four types: (1) flat angiomas, superficial and level with the skin; (2) flat angiomas level with the skin but deeply infiltrating the cutaneous and mucous layers; (3) angiomas elevated to a greater or less degree with smooth and papillated surface; (4) soft and pulsatile angiomas with fluctuating areas, and (5) erectile angiomatous tumors situated under the skin or in the mucous membrane. Most of the authors' cases came under the third group, some in the fourth and fifth and a few in the second. The type of lesion presented in this study is the raised capillary hemangioma. The patients were infants and young children. The younger the child the better the response to treatment, the authors found.

Radium in the form of 25 to 50 mg. tubes was used, with no filter except the silver capsule container. Distance between tubes and skin varied according to the dosage desired. The tubes were imbedded in dental wax and this was held in place by means of adhesive tape. Dosage was 25 to 200 mg. for from one-half to two hours at a time and if more than one tube was used they were separated by a distance of one centimeter. At least three weeks should intervene between treatments, and a longer period if inflammatory symptoms have not subsided.

In completed cases the average number of treatments was 15; average interval was 24 hrs.; average dosage 40 mg. hrs.; average distance between radium and skin was one-fourth inch. The lesions varied in size from the area of a dime to that of the palm.

The 33 cases here treated are not sufficient in number to justify conclusions as to end results but the general conclusions reached by the study are presented in the following summary by the authors themselves:

"In our experience the disadvantages and advantages of radium in the treatment of these angiomas are these: Radium therapy is expensive and time consuming—both because of the necessity of individual treatments and because of the long intervals between treatments. There is also the chance of overtreatment, with subsequent ulcer formation and very tardy healing. The possibility that telangiectasia and an atrophic skin may result, followed later by kenatosis and epithelioma, has also to be considered.

"The advantages of radium treatment are the freedom from pain, the very gradual changes in the lesion which can be watched from treatment to treatment and the probability of causing the lesion to disappear without appreciable damage to the overlying skin. In addition there is the advantage of rapid healing of ulcerations and hemorrhagic areas, the absence of scarring, under favorable conditions, or when scarring is unavoidable, the production of a smooth, supple, and comparatively inconspicuous scar. It is possible to treat successfully lesions that, because of their location are not suited to other procedures; for example, nevi of the eyelids, or others on account of their depth and extent. Most potent of all reasons for using radium in treating angiomas is the fact that radium exerts a definite, specific, selective action on the abnormal endothelial cells lining the blood vessels which are at fault in the process. Apparently this is not true of any other therapeutic agent at our command.

"Not all angiomas respond equally well to radium treatment. The port wine mark is very obstinate, since flat nevi generally are more refractory than the raised. Many nevi of small size and situated on covered parts are easily destroyed by more rapid methods.

"The scar following the skilful use of carbon dioxid snow is often insignificant. Telangectasia, classed among nevi, is better treated by electrolysis. Surgery often gives brilliant and rapid results.

"In certain selected, raised vascular nevi of the face, radium therapy yields results which cannot be achieved by other methods, especially if the treatment is commenced in early infancy."

The Effect of Radio-Active Radiations and X-Rays on Enzymes—The Effect of Radiations from Radium Emanations on Solutions of Trypsin. Raymond G. Hussey, M. D., and William R. Thompson, M. D., J. General Physiol. 5:647-658, May 1923.

EXPERIMENTS to show the effect of radiations from radium emanation upon aqueous solutions of powdered trypsin yielded the following conclusions:

"It follows that the amount of trypsin decomposed by the radiations from radium emanation depends upon the concentration of trypsin present and is proportional to the quantity of emanation expressed in millicuries and to the time of irradiation expressed in hours. It would seem that it is the active or undissociated trypsin that is affected.

"Evidence has been found which suggests that the beta radiations produce the decomposition observed for which the above statement holds.

"Qualitative evidence has been found which suggests that x-rays, gamma rays and beta rays produce identical effects in dilute trypsin solutions."

Ultra-Violet Energy in Dentistry: Biophysical Studies. By A. J. Pacini, M. D., Director of Biophysical Research, Victor X-Ray Corporation, Chicago. 12mo, 62 pp., 42 illus., Victor X-Ray Corporation, 1923. Cloth.

A clear and concise description of the physics of ultraviolet rays is given with references to the literature upon this subject.

The fundamental principles of ultraviolet application in dentistry are presented together with descriptions of apparatus and directions for technique.

Almost the entire half of the book is given over to the discussion of specific lesions. Each discussion covers the topics of definition, pathologic analysis, therapeutic indications and method of ultraviolet application with a concluding paragraph of general discussion. References to the literature are also given.

The following lesions are thus dealt with: alveolar osteolysis, infectious; abscesses; circumscribed abscess; occlusion of potential infectious locus; periodontal abscess.

Following this is a section dealing with the "Indications for the Use of Ultra-Violet Energy Abnormal Tissue Tone." Here are discussed empyema of the antrum, apicectomy, bacteria (ultraviolet death points for), bleaching, calcification of teeth, caries, cellulitis, degeneration, dentition, endameba, fistula, fracture, gingivitis, hemophilia, hyperemia, Ludwig's angina, mucous membrane, necrosis, osteomyelitis, osteoporosis, analgesic qualities of rays, pulp canal sterilization, and stomatitis.

The book is sent free of charge to physicians and dentists.